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PERCEPTIONS AND PRACTICE: THE RELATIONSHIP BETWEEN TEACHER PERCEPTIONS OF TECHNOLOGY USE AND LEVEL OF CLASSROOM TECHNOLOGY INTEGRATION

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PERCEPTIONS AND PRACTICE: THE RELATIONSHIP BETWEEN TEACHER PERCEPTIONS OF TECHNOLOGY USE AND LEVEL OF CLASSROOM TECHNOLOGY INTEGRATION

By

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PERCEPTIONS AND PRACTICE: THE RELATIONSHIP BETWEEN

TEACHER PERCEPTIONS OF TECHNOLOGY USE AND

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DEDICATION

This dissertation is dedicated to my amazing family, who are my strength and my joy. For my husband and best friend, Brian, you have put wings on my dream, doing the job of two for entirely too long so I could spend the many hours in research and writing. For my brilliant children, Michaela, Philip, Isabella, and Brighton, you have been my laughter in times of deep stress. Thank you all for walking this journey with me and ensuring my cup was always filled with strong coffee.

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ABSTRACT

This correlational-predictive study investigated the relationship between teacher perceptions of technology use and observed classroom technology integration level using the *Technology Uses and Perceptions Survey* (TUPS) and the *Technology Integration Matrix- Observation* (TIM-O) instruments, developed by the Florida Center for Instructional Technology (FCIT) at USF. Anonymized data were obtained from FCIT that included 51 teachers from a Florida school district who completed the TUPS and were observed using the TIM-O. Linear regression was used to determine the overall relationship between perceptions and technology integration, as well as the overall predictive value of teacher perceptions on technology integration level. Both were found to be statistically significant; a low-moderate relationship existed between the TUPS and the TIM-O, and the TUPS was found to be a predictor of the TIM-O level. In addition, multiple regression was used to determine the relationship between each of the seven areas of the TUPS and the TIM-O level, as well as the predictive ability of each of the TUPS domains on the TIM-O level. Although none of the domains had a statistically significant relationship or predictive value, several subgroups had significant findings in the domains of confidence and comfort, and skills and usefulness. This study supports previous research in teacher perceptions and beliefs and furthers the research by including predictive relationships. Administrators, professional developers, and support staff can use these findings to target teacher professional learning opportunities in technology integration.

Key Words: instructional technology; educational technology; K-12 education; teacher professional development; technology integration matrix; teacher perceptions

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I. INTRODUCTION

Thoughtful technology integration in the classroom is essential to prepare students to fully engage in the college and career opportunities in which they will participate after their K-12 education. To prepare students, there has been a call for more than a decade to include "21st century skills" in learning experiences, which have been broadly defined to be communication and collaboration skills, expertise in technology, innovative and creative thinking, and the ability to solve problems. This emphasis includes both what students can do and how they can apply their skills to real-world contexts (Larson & Northern Miller, 2011). Youth in the United States are already avid technology users in their everyday lives. Amanda Lenhart (2015) of the Pew Research group reported that a majority of teens in the US own or have access to devices: 87% have access to a desktop or laptop computer, 58% to a tablet computer, and 73% to a smartphone. Teens also used the devices often, with 92% reporting that that they went online daily, 24% of which used the internet "almost constantly." In their everyday lives, teens use technology to connect to others through social media and messaging applications, to post to online pin boards and discussion boards, to video call or chat, and to play video games (Lenhart, 2015).

Schools are making strides in the use of technology. Of the six trends driving educational change described by the 2016 Horizon Report, four directly relate to classroom practice: computer coding as a literacy, students as content creators, an emphasis on collaborative learning, and development of deeper learning approaches using technology (Adams Becker, Freeman, Giesinger Hall, Cummins, & Yuhnke, 2016). In addition, the report described six important developments in educational technology over the next five years. Driving technology planning in the near future is online learning and the inclusion of makerspaces, in which students create solutions to real-world problems; in two to three years, robotics and virtual reality will influence education; and in four to five years, artificial intelligence and wearable technology will impact K-12 learning environments (Adams Becker et al., 2016).

Despite these developments and trends, there are challenges to the adoption of technology in education. The 2016 Horizon Report described three levels of challenges: solvable challenges with a known solution, difficult challenges that have elusive solutions, and wicked challenges in which the issue is too complex to define or address. The two solvable challenges included involving students in authentic learning experiences and rethinking the role of teachers to become learning guides rather than content deliverers. Difficult challenges encompassed advancing digital equity so that all students have equal access to internet resources and scaling teaching innovations from the individual classroom to a wider practice within education. Finally, the two wicked challenges identified were closing the achievement gap and using personalized learning to address the learning needs of every student (Adams Becker et al., 2016).

This type of environment requires teachers to integrate technology effectively and in authentic ways. Benjamin Herold (2015) of *Education Week* pointed out that, despite the increased availability of new technology in the classroom, a "mountain of evidence indicates that teachers have been painfully slow to transform the ways they teach" (para. 2). He further identified several factors influencing this reality, such as teachers' beliefs about instruction, lack of expertise, lack of support, and policies at various levels that did not encourage teachers to explore and experiment with technology (Herold, 2015).

This research study sought to advance the understanding of some of the factors involved in teacher integration of technology in the classroom. Specifically, the relationship between teacher perceptions of technology use, and the observed level of technology integration, was investigated. In addition, the extent that teacher perceptions predict technology integration levels was explored.

Background

Since 1998, the International Society for Technology Education (ISTE) has released standards for technology use by teachers, students, and other educational professionals (ISTE, 2016). Over this period, the focus of the standards for students shifted from learning with technology, to using technology to learn, to the current focus of transformative learning with technology. Transformative learning within the ISTE standards refers to "future-ready" student learning that equips each student to become an empowered learner, digital citizen, knowledge constructor, innovative designer, computational thinker, creative communicator, and global collaborator (ISTE, 2016). This emphasis on transformative learning places a greater directive on the classroom teacher to use technology in new ways and to provide meaningful learning experiences for students that incorporate technology as they build 21st century skills.

Infusion of technology in learning. Professional organizations have called for technology to be included in programs, such as adolescent literacy, pointing to technology as both a facilitator and a medium for literacy teaching and learning (Sternberg, Kalen, & Borck, 2007). In discussing the pedagogy of technology integration, Okojie, Olinzock, and Okojie-Boulder (2006) stated that "infusing technology into a curriculum is less likely to make an impact on students' learning if technology is not considered as an integral part of instructional delivery" (p. 67). However, technology on its own is not transformative; if it is used merely as a textbook replacement or to show PowerPoint presentations, the full promise of educational technology is not realized (Herold, 2015). To fully integrate technology into the learning environment requires a notable shift in both how the teacher teaches and how he or she supports student learning. The 2016 Horizon Report identified rethinking the role of the teacher in this way as a significant, but solvable challenge impeding technology adoption in K-12 education (Adams Becker et al., 2016).

The adoption and dissemination of new technologies throughout a system is a multi-faceted issue. In his book, *The Diffusion of Innovations,* Everett Rogers (2003) presented a theory of how new ideas and technologies, or innovations, spread throughout a system. In any given population faced with the acceptance of new innovations, Rogers identified five characteristics of acceptance. In order from the most "venturesome" to most "traditional," approximately 2.5% of a group are considered to be *Innovators*, 13.5% are *Early Adopters*, 35% are the *Early Majority*, 34% are the *Late Majority*, and 16% are considered *Laggards* (Rogers, 2003). In order for innovations to become self-sustaining, they must reach wide adoption among the members of the given social group. Although Rogers' theory was originally written for innovations in agriculture, when applied to education, the social group includes teachers, administrators, and district personnel. For the technology-enabled classroom, in addition to the acceptance of new technologies, new teacher skills are required to become adept at a variety of approaches that support content delivery, learner support, and assessment using the technology.

Technology usage. Of primary concern is how teachers and students use technology in the classroom. Even as far back as 2009, the US Department of Education found that 99% of classrooms had computers in them, or could be brought in, with an average computer to student ratio of one to 1.7 (Gray, Thomas, & Lewis, 2010). However, only 40% of teachers reported using computers in their classroom often, while 29% of teachers stated that they rarely or never used computers in the classroom. When the specific activities for which teachers reported that they and students accessed technology were disaggregated, the use level largely remained at the basic level, such as managing student records, word processing, creating presentations or spreadsheets, using the internet, and completing drill and practice activities. (Gray et al., 2010). Given this data, Clark and Zagarell (2012) described student technology use as a "multi-tier conundrum" in that many learners had only a superficial experience with technology use in the classroom.

Since the Department of Education report, the trends in use of technology in schools has improved. The 2016 Horizon Report identified computer coding as a literacy and students as content creators as short-term trends driving educational technology adoption in the next one to two years (Adams Becker et al., 2016). Further, it recognized collaborative learning and deeper learning approaches using technology as mid-term trends in education over the next three to five years. Nonetheless, the report also identified the moving of teaching innovations into mainstream practice as a difficult challenge, one that is understood, but for which solutions are elusive.

Teacher perceptions and technology use. Lynette Gorder (2008) examined the relationship between teacher training and the teachers' perception of their own level of technology integration. She found that even after attending a teacher academy on advanced technology, teachers reported that they used technology for professional activities or to deliver content, but did not use it as much for teaching and learning. When looking at the demographic characteristics of the teachers in the study, she noted that there was little difference in technology integration between males and females, but that teachers of grades 9-12 tended to integrate technology more often than teachers of either grades K-5 or 6-8. In later research, the use of technology in education remained superficial. Ruggiero & Mong (2015) conducted interviews of teachers about their experience in integrating technology, and concluded that although technology use was pervasive, the majority of teacher responses continued to involve teacher-centered use, such as posting assignments on an interactive board or using a document camera to show math problems.

Technology integration tools. To guide teachers and administrators in the practice of integrating technology, the Florida Center for Instructional Technology (FCIT) at the University of South Florida developed the *Technology Integration Matrix* (TIM). The TIM is based on the theory of social constructivism in which new learning occurs when students interact with each other to build new knowledge or gain new understanding (Allsopp, Hohlfeld, & Kemker, 2007). It also provides a common vocabulary for technology integration across content areas and grade levels (Harmes, Welsh, & Winkelman, 2016). Conceptualized in 2003, the TIM was field tested in 2005 by Allsopp et al. (2007), and revised to its current version in 2011, after expert review and additional field tests in several Florida school districts (Harmes et al., 2016). The technology matrix describes technology integration over five levels and across five learning environments, for a total of 25 descriptors of technology use during a learning activity or lesson.

The TIM levels of technology integration were initially based on the work of Apple Classroom of Tomorrow (ACOT) (Harmes et al., 2016). According to the ACOT model, teachers progress through stages as they learn to implement technology in the classroom: *Entry*, *Adoption*, *Adaptation*, *Appropriation*, and *Invention* (Apple Computer, Inc., 1995). In developing the TIM, the ACOT levels formed the starting point, then expanded to the current levels used in the TIM: *Entry*, *Adoption*, *Adaptation*, *Infusion*, and *Transformation* (Harmes et al., 2016). Although the names of the first three levels were the same, Harmes et al. (2016) stated that the TIM represented a broader range of possible ways to enhance instruction. One significant difference between the TIM and the ACOT models is that, while the ACOT model focused on teacher development, the TIM levels focused on the pedagogy of a specific lesson. As described by the Florida Center for Instructional Technology (n.d.), the following are brief explanations of each level of the TIM.

Entry. In the entry level of the TIM, teachers begin to use technology in instruction, but technology is only used to deliver content to students. Students passively receive the content information, do not use technology in collaborative work or real-world settings, and are highly monitored through step-by-step instructions. The classroom setting is teacher-centered and the teacher is the main user of technology.

Adoption. In adoption level, students begin to use technology in conventional or procedural ways. Students use technology to build knowledge through the conventional use of tools or exploration of some content in meaningful context. The classroom environment remains largely teacher-centered, but students have started using technology during the lesson.

Adaptation. At adaptation, students explore technology independently, while the teacher facilitates student learning. Although the use of technology is still conventional, students have some choice options of which tool to use and how to explore content using the technology tool. Students are involved with the collaborative use of technology, using technology to build knowledge, and engaging in activities with technology that are connected to their lives. The classroom environment shifts toward being student-centered.

Infusion. At infusion level, the classroom environment is clearly student-centered, as the teacher provides the learning context, then allows the students to choose the technology needed to explore the content. Students are self-directed in using technology tools and are given choices regularly in what tool to use and how to approach authentic, collaborative, and meaningful tasks. Student use of technology tools to monitor their own progress toward goals is seamless and flexible.

Transformation. This final level of technology integration includes lessons and activities that are not possible to complete without the use of technology. The classroom environment is highly student-centered as the teacher encourages and facilitates student technology use that is innovative and unconventional. Use of technology is extensive and used for higher order, global, and collaborative learning activities.

In addition, the TIM website, www.mytechmatrix.org, provides classroom video examples of each TIM level in Active, Collaborative, Constructive, Authentic, and Goal-Directed learning environments (Harmes et al., 2016). For each environment, the degree to which technology is used and how it is implemented increases in amount and depth as the lesson moves from Entry to Transformation. Active learning environments are ones in which students actively discover, process, and apply learning using technology, rather than passively receiving content. In a Collaborative environment, technology is used for students to collaborate with peers and experts outside the classroom. During Constructive lessons, students use technology while building content knowledge and linking new information to prior knowledge. Authentic learning activities use technology to investigate real-world issues and may extend the learning beyond the classroom. Goal-Directed learning environments involve technology used for reflection and planning activities, such as setting goals, monitoring progress, and evaluating learning outcomes (Harmes et al., 2016). By choosing a classroom environment and TIM level on the online matrix, extended descriptors of the setting, what students and teachers do at the given level, and video examples of what technology integration looks like across several content areas in actual classroom lessons, become available (Florida Center for Instructional Technology, n.d.). Users can alternately go directly to content specific resources by selecting the website options of “Subject Area Index” or “Grade Level Index” in the site dropdown menu.

Furthermore, FCIT developed several evaluation tools that provide insight into classroom technology use (Harmes et al., 2016). Of the available tools, two will be used in this study, the *TIM Observation Tool* (TIM-O) and the *Technology Uses and Perceptions Survey* (TUPS). The TIM-O is a web-based classroom observation instrument that produces a technology integration profile of an observed lesson in terms of the TIM (Florida Center for Instructional Technology, n.d.). The second tool, the TUPS, is used to gather information from teachers about their beliefs regarding the role of technology in the classroom (Harmes et al., 2016). It examines seven areas of teacher perceptions and use of technology: technology access and support, preparation for technology use, perceptions of technology use, confidence and comfort level, teacher and student use, technology skills and usefulness, and technology integration (Florida Center for Instructional Technology, n.d.).

This study examined the relationship between teacher perceptions and observed technology integration levels in the classroom. An understanding of underlying user perceptions, as well as the extent to which these perceptions are related to the level of classroom technology integration, may illuminate additional opportunities for targeted professional development activities for teachers. Furthermore, if specific teacher perceptions predict the level of technology integration in the classroom, thoughtful technology training and supports can be implemented in teacher development initiatives.

Purpose Statement

The purpose of this study was to explore the relationship between the seven areas of technology use perceptions (technology access and support, preparation for technology use, perceptions of technology use, confidence and comfort level, teacher and student use, technology skills and usefulness, and perception of technology integration), and the level of teacher technology integration (*Entry*, *Adoption*, *Adaptation*, *Infusion*, and *Transformation*) in the classroom. Further, this study sought to determine which of the seven areas of technology use perception represented the most robust predictor of technology integration level in the classroom.

Research Questions

For this study, the primary research question was: What is the relationship between teacher perceptions of technology as measured by the *Technology Uses and Perceptions Survey* (TUPS) and teacher technology integration level as measured by the *Technology Integration Matrix-Observation Tool* (TIM-O)? In studying this relationship, the following three sub-questions were investigated:

(1) What are the relationships between each of the seven areas of the TUPS and teacher level of technology integration on the TIM?

(2) Does the TUPS represent a significant predictor of TIM level as measured by the TIM-O?

(3) Which of the seven areas of the TUPS represents the most robust predictor of teacher technology integration level?

Research Hypotheses

For the primary research question, "What is the relationship between teacher perceptions of technology as measured by the *Technology Uses and Perceptions Survey* (TUPS) and teacher technology integration level as measured by the *Technology Integration Matrix-Observation*

Tool (TIM-O)," a strong, positive relationship was hypothesized.

H_0: There is no statistically significant correlation between teacher perceptions of technology use and the technology integration level in the classroom.

H_A: There is a strong, statistically significant, positive correlation between teacher perceptions of technology use and the technology integration level in the classroom.

For sub-question one, "What are the relationships between each of the seven areas of the TUPS and teacher level of technology integration on the TIM," it was hypothesized that each of the areas would have a positive correlation to technology integration in the classroom, with teacher confidence and comfort level having the most robust and statistically significant positive correlation.

H_0: There is no statistically significant correlation between each area of teacher perceptions of technology use and the technology integration level in the classroom.

H_A: There is a statistically significant, positive correlation between each area of teacher perceptions of technology use and the technology integration level in the classroom, with teacher confidence and comfort level having the most robust correlation.

In sub-question two, "Does the TUPS represent a significant predictor of TIM level as measured by the TIM-O," it was hypothesized that the TUPS is a significant predictor of technology integration level in the classroom.

H_0: The TUPS is not a statistically significant predictor of technology integration level in the classroom.

H_A: The TUPS is a statistically significant predictor of technology integration level in the classroom.

Finally, for sub-question three, "Which of the seven areas of the TUPS represents the most robust predictor of teacher technology integration level," it was hypothesized that teacher confidence and comfort level is the most robust predictor of teacher technology integration level.

H_0: None of the seven areas of the TUPS represents a statistically significant predictor of technology integration level in the classroom.

H_A: Of the seven areas of the TUPS, teacher confidence and comfort level represents the most robust, statistically significant predictor of technology integration level in the classroom.

Methodology

Subjects and sampling procedures. The study subjects were K-12 educators from a school district in Florida. Through a collaboration with FCIT, several school districts in Florida were initially identified as having both TIM-O and TUPS data (J. Welsh, personal communication, January 13, 2017). The Florida Department of Education allows access to school district data if all identifiable information has been removed. FCIT requested and received permission to release the de-identified data from one county for this study (J. Welsh, personal communication, March 6, 2017). Therefore, the subjects and school district were anonymized. The sample was a purposive sample of K-12 educators from one school district who completed the TUPS and were observed during a lesson as recorded on the TIM-O instrument. The sample included 51 educators from 18 schools, with 2-37 years of teaching experience, who taught grades 1-12 and in subjects across the curricula. The request for data access was completed after IRB approval of exempt status. The use of existing data was an accepted condition for IRB exemption when the data are publicly available or de-identified (National Institutes of Health, 2016).

Data collection procedures. In the selected county, teachers were previously asked to complete the TUPS to determine a baseline measure of teacher technology use perceptions, followed by independent observations of technology integration levels of lessons, measured by the TIM-O. FCIT provided de-identified data files with 345 unique teacher TUPS responses and 817 recorded TIM-O observations. The TIM-O responses included multiple observations for many teachers. Through a discussion with Dr. Welsh, it was determined that only the maximum TIM levels observed would be included in this study as that represented the teachers' highest technology integration lesson (personal communication, March 10, 2017). These data were matched by the researcher using the anonymized participant identification number, which resulted in 51 paired TUPS and TIM-O records for analysis.

Instrumentation. The two instruments used in this study were the *Technology Uses and Perceptions Survey* (TUPS) and the *Technology Integration Matrix-Observation* (TIM-O) tool developed by the FCIT at the University of South Florida, College of Education. In this study, the independent variable was the teacher perceptions of technology use, measured by the TUPS, and the dependent variable was the level of technology integration in the classroom, measured by the TIM-O. Each instrument was developed, refined, and validated by a panel of educational technology experts at the Florida Center for Instructional Technology, field tested in the state of Florida, and was recommended by the Florida Department of Education as part of the legislated Digital Classroom Plan for public schools.

The TUPS was used to measure teacher perceptions of technology use. This survey is a 200-item web-based survey to measure teacher perceptions in seven areas: technology access & support, preparation for technology use, perceptions of technology use, confidence and comfort using technology, technology integration, teacher and student use of technology, and technology skills and usefulness (Florida Center for Instructional Technology, n.d.). The TUPS was developed by expanding and updating surveys used in two separate studies (Barron, Kemker, Harmes, & Kalaydjiam, 2003; Hogarty, Lang, and Kromrey, 2003).

To measure the teacher technology integration level, the TIM-O tool was used during classroom walk-throughs to determine the integration level (*Entry*, *Adoption*, *Adaptation*, *Infusion*, or *Transformation*) within a specific lesson (Florida Center for Instructional Technology, n.d.). The TIM-O is based on the original online TIM resource and is meant to be used at the lesson level. Therefore, it is probable that a teacher will reach different levels for various lessons, depending on the pedagogy required for the individual lesson. For this study, only the highest level observed was used. The TIM-O is Web-based and uses skip-logic questions of observable classroom characteristics to identify the classroom environment and TIM level consistently, regardless of observer understanding of the TIM (Florida Center for Instructional Technology, n.d.).

Analysis

Gay, Mills, and Airasian (2012) defined correlational research as seeking to determine if, and to what extent, a relationship exists between two or more variables and may be in the form of a relationship study or a predictive study. This study involved both subtypes of correlational research to determine the relationship between teacher perceptions of technology use and technology integration in the classroom, as well as whether the perceptions predicted the level of technology integration. An important aspect of correlational research is that correlation does not imply causation; rather, a correlation indicates that the variables are related and, possibly, that one variable predicts the other (Gay et al., 2012).

In analyzing the data, descriptive statistics were compiled. Demographic statistics for the teacher participants included teacher gender, ethnicity, highest degree earned, years of teaching experience, subject area and grade levels taught, number of students per class, and number of years of teaching using technology. The frequency of teachers at each level of technology integration (entry, adoption, adaptation, infusion, and transformation) and selected categories of user perceptions were determined and reported in Appendix B. Finally, the mean scores of teachers in the seven categories of user perceptions and five levels of technology integration were calculated.

Composite scores of appropriate items on the TUPS were computed and combined into a super composite for analysis. For the TIM-O data, only the highest level recorded was used. A correlational analysis was performed to ascertain the overall relationship between the TUPS and teacher technology integration level using the super composite scores and highest TIM-O scores. To determine the relationships between each of the seven areas of the TUPS and teacher level of technology integration on the TIM, each sub-domain was disaggregated into composite scores, then a correlation analysis was again completed. The correlation coefficient, or *r*-value, was interpreted following the parameters described by Gay et al. (2012).

A prediction study was completed to determine which independent variable (the predictor) was most highly related to the dependent variable (the criterion) (Gay et al., 2012). In this study, the teachers' technology perceptions were the predictors for the criterion variable of technology integration level. A simple linear regression model was calculated to determine if the TUPS was a significant predictor of the technology integration level measured by the TIM-O. In addition, this prediction model was investigated through multiple regression analysis to ascertain which of the seven areas of the TUPS represented the most robust predictor of the technology integration level.

Study Assumptions, Delimitations, and Limitations

Assumptions. In this study, several facets have been accepted as true.

(1) Teacher responses to the TUPS survey were assumed to be accurate portrayals of their personal perceptions.

(2) FCIT published information describing the TIM-O instrument stated that individual observers can accurately determine the technology integration level using the Web-based TIM-O skip-logic questioning tool during classroom walk throughs, regardless of their depth of knowledge of the *Technology Integration Matrix* (Florida Center for Instructional Technology, n.d.). It is assumed that this information is accurate and the TIM level identified through this process represents the integration level of the observed lesson.

(3) As data were obtained from 18 schools throughout the district, it is assumed that the population studied depicts a representative cross-section of administrator emphases, cultures, and school characteristics within the overall school district profile.

Delimitations. This topic was chosen to explore the relationship between perceptions and technology integration level using the TUPS and TIM-O instruments. Although other instruments could have been chosen, these tools were specifically used in light of the emphases placed on them by the state of Florida Department of Education Digital Classroom Plan (Florida Department of Education, 2015). Though not required, the Florida Department of Education recommends their use as tools to measure technology integration initiatives and professional development efforts in Florida school districts. In addition, in-service teachers were studied as they are currently working with students, making daily decisions about technology in the classroom. Pre-service teachers were excluded as they have not yet entered full-time teaching.

Limitations. Study limitations are factors within the study that cannot be controlled, but may affect the results (Gay et al., 2012). For this study, the limitations are as follows:

1. The data were collected from an anonymous school district in Florida. Although it was identified as a large district, the specific demographics of the school district were not known, and therefore this study has limited generalizability.
2. As the school district was not known, information about individual school and administrator technology initiatives, available digital tools, or previous technology integration professional development efforts was not available, therefore, the positive or negative effects of these environmental variables could not be determined.
3. The observational data from the TIM-O is based on specific lessons, and may not be indicative of the overall technology integration level of individual teachers.

Definition of Terms

Active learning environment (TIM): On the *Technology Integration Matrix*, a characteristic of the learning environment in which students are actively engaged in discovering, processing, and applying the content using technology (Harmes et al., 2016).

Adaptation level (TIM): The third level of technology integration on the *Technology Integration Matrix*. In this level, multiple technology tools are used during learning activities. The teacher continues to decide how technology is used, but student use becomes more flexible (Florida Center for Instructional Technology, n.d.).

Adoption level (TIM): The second level of technology integration on the *Technology Integration Matrix*. In this level, technology use is procedural and student use is limited and highly regulated by the teacher (Florida Center for Instructional Technology, n.d.).

Authentic learning environment (TIM): On the *Technology Integration Matrix*, a characteristic of the learning environment in which students use technology to investigate real-world issues and may extend the learning beyond the classroom (Harmes et al., 2016).

Collaborative learning environment (TIM): On the *Technology Integration Matrix,* a characteristic of the learning environment in which technology is used by students to collaborate with peers and experts outside the classroom (Harmes et al., 2016).

Constructive learning environment (TIM): On the *Technology Integration Matrix*, a characteristic of the learning environment in which students use technology to actively build content knowledge and link new information to prior knowledge (Harmes et al., 2016).

Educational technology: "Tools and resources that are used to improve teaching, learning, and creative inquiry" (Adams Becker et al., 2016, p. 34).

Entry level (TIM): The first level of technology integration on the *Technology Integration Matrix*. In this level, the teacher is beginning to use technology tools, and student use is for rote drill and practice or may only involve observing the teacher using technology, such as when using a PowerPoint to present content (Florida Center for Instructional Technology, n.d.).

Goal-directed learning environment (TIM): On the *Technology Integration Matrix*, a characteristic of the learning environment in which technology is used in reflection and planning activities, such as setting goals, monitoring progress, and evaluating learning outcomes (Harmes et al., 2016).

Infusion level (TIM): The fourth level of technology integration on the *Technology Integration Matrix*. In this level, the availability of technology tools is broad and has significant variety. Students are involved in making decisions of how and when to use technology to learn and apply content knowledge (Florida Center for Instructional Technology, n.d.).

Maker spaces: A "place where students can gather to create, invent, tinker, explore, and discover using a variety of tools and materials" (Rendina, 2015, para. 5).

Technology: "Digital devices, software, and connectivity that allow the use of digital content in the classroom" (Harmes et al., 2016, p. 162).

Technology integration: The use of technology by students and teachers to "enhance, extend, or enrich learning" (Harmes et al., 2016, p. 162).

TIM: *The Technology Integration Matrix*, a "pedagogically-centered model for planning, describing, and evaluating technology integration" (Harmes et al., 2016, p. 162).

TIM-O: The *TIM Observation Tool* used by classroom observers during a walk-through lesson observation. The TIM-O establishes a TIM level for the specific lesson environment being observed (Florida Center for Instructional Technology, n.d.).

Transformative learning: Learning that promotes future ready skills, such as the student as an empowered learner, digital citizen, knowledge constructor, innovative designer, computational thinker, creative communicator, and global collaborator (ISTE, 2016). Transformative learning with technology is distinguished from basic technology use, such as rote drill and practice, simple internet research, and traditional writing and presentation preparation.

Transfusion level (TIM): The fifth level of technology integration on the *Technology Integration Matrix*. In this level, students are self-directed in using technology to accomplish higher-order learning outcomes that would be difficult or impossible without the use of technology. The teacher functions as a guide at this level (Florida Center for Instructional Technology, n.d.).

TUPS: The *Technology Uses and Perceptions Survey*, a web-based tool used to capture teacher beliefs about the role of technology in the classroom, comfort and confidence levels in using technology, and the pedagogy of using technology in learning activities (Florida Center for Instructional Technology, n.d.).

II. REVIEW OF LITERATURE

John King, former United States (U.S.) Secretary of Education, described the vital role of technology in U.S. education as the "ability to level the field of opportunity for students" (U.S. Department of Education, 2017). That potential certainly exists. The 2016 Horizon Report identified six short-term, medium-term, and long-term trends driving educational technology planning and decision making in K-12 education. Short-term trends occurring in the next one to two years involved students as creators of content and the inclusion of computer coding language as a literacy; medium-term trends over the next three to five years incorporated deeper learning approaches and an emphasis on collaborative learning; and long-term trends driving technology adoption for five years or more included redesigning learning spaces and rethinking how schools work overall (Adams Becker et al., 2016). As these trends become pervasive throughout K-12 schools, leveling the field for all students becomes a possibility.

However, it remains a reality that many schools in the U.S. do not use technology adequately to improve learning across all grade levels (U.S. Department of Education, 2017). The director of the U.S. Office of Educational Technology reiterated that this reality, "underscores the need- guided by new research- to accelerate and scale up the adoption of effective approaches and technologies" (U.S. Department of Education, 2017, p. 7). The 2016 Horizon Report described "significant challenges" that, if not resolved, will impede technology adoption in K-12 schools (Adams Becker et al., 2016, p. 20). These challenges were divided into three categories: solvable with what is currently known, difficult challenges that were understood but have elusive solutions, and wicked challenges that were too complex to fully define or address. The difficult challenges included advancing digital equity and scaling teacher innovations outside the individual classroom, while the wicked challenges involved closing the achievement gap and integrating personalized learning in the learning process (Adams Becker et al., 2016). Research indicated that using technology in innovative ways may be part of the solution for these challenges.

The two challenges in the 2016 Horizon Report identified as solvable were creating authentic learning experiences and rethinking the roles of teachers. Considering the role of the teacher is vital, as researchers consistently recognized that the deciding factor in successful integration of technology into the learning environment is the classroom teacher (Clark & Zagarell, 2012). The Horizon Report cited a survey by Samsung and GfK, which found that although 81% of U.S. educators viewed technology "as an important gateway to provide hands-on experiences for students," one-third of the educators surveyed "felt that their schools did not provide adequate support to help them integrate technology in the classroom" (as cited in Adams Becker et al., 2016, p. 24). Clark and Zagarell (2012) furthered this argument by asserting that the only way for teachers to learn how to enhance lessons with technology was through effective training.

This chapter will review educational technology in the United States, including trends, research, and current uses. Further, it will examine previous research on factors affecting teacher integration of technology in the classroom. For inclusion in this review of literature, articles were chosen using the following criteria: published in the last five years, since 2011, or representing foundational studies in educational technology, focusing on the use of technology in

K-12 educational contexts, or studies on pre- or in-service teachers and their instructional technology practices, as well as their beliefs and perceptions about technology in the classroom.

Educational Technology in the United States

In its strategic plan for fiscal years 2014-2018, The U. S. Department of Education outlined six goals to guide its work in the areas of: (1) postsecondary and adult education, (2) elementary and secondary education, (3) early learning, (4) equity in educational opportunities, (5) continuous improvement of the education system, and (6) improvement of capacity within the department (U.S. Department of Education, n.d.). Within these goals, several objectives related to the role of educational technology in schools (see Appendix A). Specifically, strategic objective 1.4 called for increased access to science, technology, engineering, and math (STEM) opportunities that lead to completion of postsecondary programs; objective 2.5 emphasized increasing the quantity and quality of STEM teachers so that more students have more opportunities to access deep STEM learning experiences; objective 4.1 endeavored to increase access to educational opportunities for all students that removes barriers and closes the achievement gap; and objective 5.4 strove to "accelerate the development and broad adoption of new, effective programs, processes, and strategies, including educational technology" (U.S. Department of Education, n.d., p. 9).

Current developments in educational technology are in line with the Department of Education's goals and objectives. The 2016 Horizon Report (see Figure 1) postulated that in one year or less online learning and makerspaces will have wide-spread adoption; within two to three years, robotics and virtual reality will be adopted in education; and in four to five years, education will see the adoption of artificial intelligence and wearable technologies (Adams Becker et al., 2016). In acknowledgement of the value of technology in the classroom, the U.S.

Department of Education described specific benefits that technology can offer the learning environment, for example, enabling engaging and relevant personalized learning experiences, creating real-world and problem-based learning challenges, moving learning outside the school setting with virtual opportunities, helping learners pursue their personal interests and passions, and making "transformative learning opportunities" (p. 17) available to all learners (U.S. Department of Education, 2017). Further, access to technology has become a "prerequisite for

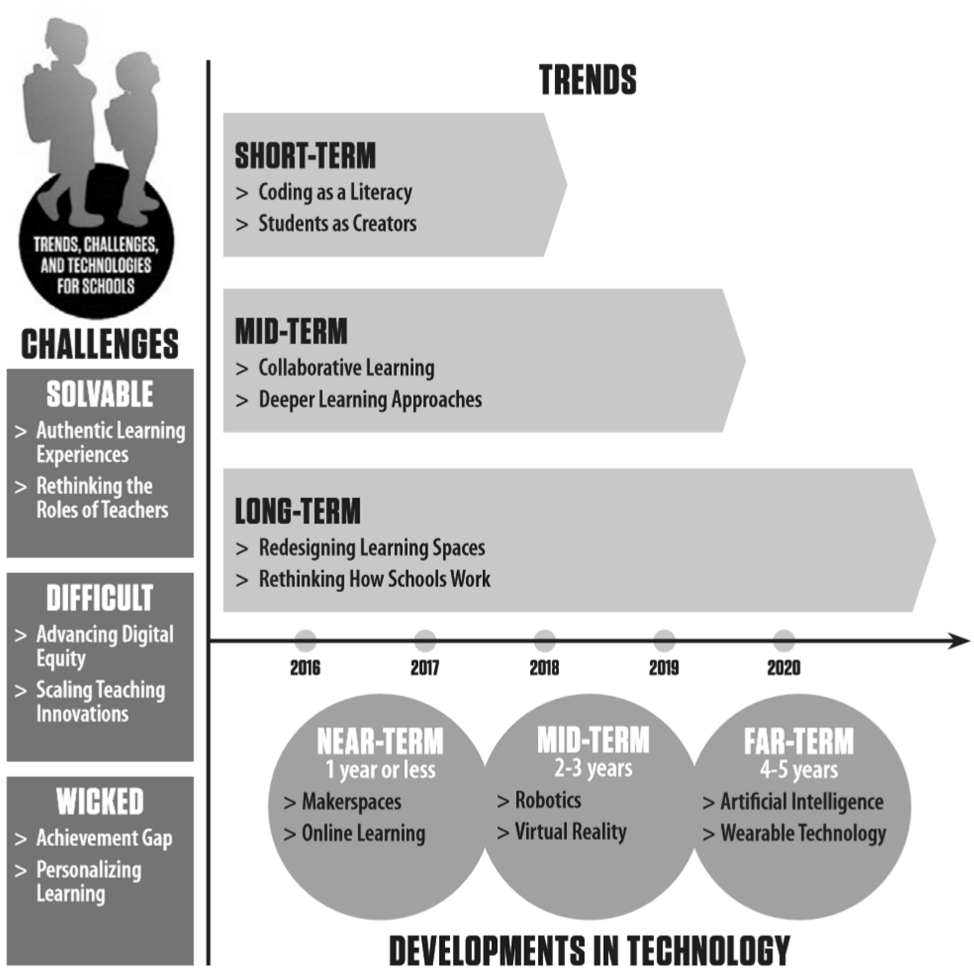


Figure 1. Trends, Developments, and Challenges in Educational Technology from the *NMC/CoSN Horizon Report: 2016 K-12 Edition* (Adams Becker, et al., 2016).

full participation in high-quality education opportunities" (p. 3) with the proliferation of digital learning resources, the use of the internet to complete school and personal tasks, access to summer programs and scholarships, and participation in college coursework (U.S. Department of Education, 2014). For this reason, the Department of Education asserted that the conversation has shifted from *whether* technology should be used, to *how* technology can be used to improve learning experiences for all students (U.S. Department of Education, 2017).

Technology Usage

Personal use of technology is ubiquitous. As described by Lim, Zhao, Tondeur, Chai, & Tsai (2013), technology is commonly used to "seek and provide resources and information, express ourselves, communicate with others, create, consume, and play, often assuming new and multiple identities" (p. 60). They further reported that 9.5 million users worldwide accessed just the top three massively multiplayer online games, *Lineage I*, *Lineage II*, and *World of Warcraft*, while people of all ages merged the physical and virtual worlds through posting to blogs, discussion forums, and social media sites. Research on technology use by youth in the United States supported these findings. The Pew Research Group found that a majority of teens in the U.S. own or have access to devices: 87% accessed a desktop or laptop computer, 58% a tablet computer, and 73% a smartphone (Lenhart, 2015). These devices were used often, with 92% reporting that that they went online daily, and 24% of these used the internet "almost constantly" (p. 2). Teens most often used technology to connect to others through social media and messaging applications, to post to online boards, to video call or chat, and to play video games (Lenhart, 2015).

In 2001, Marc Prensky defined different types of technology users. Although not all researchers agree on the terms, Prensky identified users who had been born into the digital environment of today as *Digital Natives*, while those users who were born before the vast access to technology were designated *Digital Immigrants* (Prensky, 2001). Zur and Zur (2016) further distinguished between categories of digital natives and digital immigrants: *avoiders* generally used little to no technology when possible, *minimalists* used technology reluctantly or only when necessary, *tourists* were visitors to the digital world and were able to use technology effectively as needed, *enthusiastic*, or eager adopters, had fun with technology and used it extensively, *innovators* worked with technology to improve it, and *addicts* were heavy users that were extremely protective of their right to be online (Zur & Zur, 2016). The divergence between different types of technology users is important when considering the needs of students, who have spent most of their lives using technology, and the perspective of teachers, who oftentimes have had to relearn processes using new technology. Although the date may be fluid, Rasmussen (2015) specified the cutoff year between the two groups as 1974, with the revolutionary release of the Apple II computer just a few years later in 1977. Using teacher demographic data from 2011, Rasmussen (2015) pointed out that just under half of U.S. teachers, 47%, were under 40 and considered digital natives, while 53% of teachers were digital immigrants (Rasmussen, 2015).

Research pointed out that, due to their long-term access to technology, the misconception is that digital natives already had the technology skills they needed for college and career pursuits. Clark and Zagarell (2012) described the digital native experience with technology as superficial and labeled them as novices. This cursory experience followed students into college. Thompson (2013) surveyed the technology use patterns of 388 university freshmen and found that only two out of eight categories of digital technologies were used frequently by most students. The most frequently used categories were rapid communication, such as posting to social media and using a cell phone for calling and texting, as well as Web resources, or using the Web, to explore topics and look up facts, watching online videos, and listening to online music (Thompson, 2013). Her conclusion: the range of technologies students were proficient in was limited, therefore, educators could not assume that students had the skills or were using the technology to its maximum potential in their learning.

A distinction was made in the literature between technology used for lifestyle verses technology skills used for the workplace. In discussing research in the United Kingdom, the European Computer Driving License (ECDL) Foundation (2014), pointed out that technology use by young people, composed primarily of social applications, content consumption, and information retrieval, was not equivalent to the skills needed to obtain a job, engage with government, or manage personal business, such as financial and health care requirements. Supporting this assertion, the ECDL Foundation (2014) report cited a German study by BCS.org, which found that, although young people were skilled in everyday lifestyle tasks, less than 20 percent could complete simple tasks considered necessary in the workplace, for example, applying paragraph styles or changing spreadsheet chart types. The report further concluded that younger users consistently overestimated their skill level with information, communication, and technology (ICT), reporting that, although a 2014 study found 84 percent of respondents described their own knowledge level as very good or good, as much as 49 percent scored bad or very bad on practical tests (ECDL Foundation, 2014). It is this overconfidence, as stated in an earlier study by Clark and Zagarell (2012), that may become a barrier for digital natives, because they may feel that they do not need additional training using technology.

Beginning in 1998, and in recognition of the need to prepare students more adequately, the International Society for Technology Education (ISTE) has published standards for students for the use of technology in learning. The most current iteration of these standards, published in 2016, emphasized the "skills and qualities we want for students, enabling them to engage and thrive in a connected, digital world" (ISTE, 2016, p. 1). The standards for students addressed the characteristics of becoming empowered learners, digital citizens, knowledge constructors, innovative designers, computational thinkers, creative communicators, and global collaborators. ISTE (2016) further elaborated that both students and teachers must be responsible for achieving the foundational technology skills needed to master the skills throughout the students' academic careers.

Deeper Learning and Technology

Larson and Northern Miller (2011) described the essence of 21st century skills as those that involved "strong communication and collaboration skills, expertise in technology, innovative and creative thinking skills, and an ability to solve problems," emphasizing "what students can *do* with the knowledge and how they *apply* what they learn in authentic contexts" (p. 121). Moreover, they cited other researchers in concluding that these skills are not new, only newly important to the skills needed to fully participate in college and career opportunities (Larson & Northern Miller, 2011). Professional organizations supported this conclusion, calling for learning experiences that included "design, media production, self-expression, research, analysis, communication, collaboration, and computer programming" to prepare students for the requirements of college and careers they will encounter in the future (U.S. Department of Education, 2014, p. 3).

Because this type of learning goes much deeper than skill-building, The National Research Council (NRC, 2012) renamed this blend of knowledge and skills as "21st century competencies" (p. 6). The 2016 Horizon Report defined these skills and competencies as deeper learning (Adams Becker et al., 2016), while the U.S. Department of Education (2014) elucidated deeper learning as "learning with understanding" (p.4). The NRC (2012) echoed Larson and Northern Miller (2011) in identifying the transfer of these competencies to new situations as deeper learning. Pellegrino and Hilton of the NRC (2012) reported that "extensive and rigorous" research in the learning sciences indicated "that deeper learning and complex problem solving involves the interplay of cognitive, intrapersonal, and interpersonal competencies" (National Research Council, 2012, p. 8). Corroborating this conclusion, the Department of Education further described what people need to learn as both 21st century competencies and content expertise, which included multimedia communication, as well as the non-cognitive competencies of solving everyday problems, forming relationships, working cooperatively, developing self-awareness, and caring for oneself (U.S. Department of Education, 2017). As described in the NRC's 2012 report, deeper learning may involve shared learning experiences, the development of expertise in a domain of knowledge or performance, and having the product of transferable knowledge (National Research Council, 2012).

Engaging in deeper learning and the development of transferable 21st century competencies requires systematic instruction with sustained practice, becoming a "recursive, mutually reinforcing cycle" as each activity supports the other's growth (National Research Council, 2012, p. 8). Pedagogical approaches to deeper learning included the use of multiple representations in considering the complexities and connections between ideas, a focus on big ideas over learning isolated facts, and incorporation of real-world problems, project based experiences, and challenges that are meaningful to students (U.S. Department of Education, 2014). Educational technology can be a significant contributor to deeper learning environments by giving students access to multiple online resources that integrate, compare, and contrast information; using the internet to access a wider range of materials, enabling students to become experts in topics; exploring phenomena and data sets using authentic tools; differentiating learning through game-based programs; and giving students a forum to become producers of content, rather than solely content consumers (U.S. Department of Education, 2014). Students need these learning experiences to be fully prepared for their future endeavors, however, not all students are exposed to this type of deeper learning.

Digital Divide

Researchers have described various technology gaps that currently exist in schools. Lim, Zhao, Tondeur, Chai, and Tsai (2013) identified two gaps: a usage gap, in which technology use inside school was less intensive and less extensive than outside school, and an outcome gap between the investment in technology and measurable student outcomes. According to some measures, the digital access gap has been largely closed due to increased federal and state funding of varied educational initiatives (U.S. Department of Education, 2017). The U.S. Department of Education Strategic Plan (2017) identified a new kind of digital divide, a "digital use divide" (p. 21), in which some students used technology passively through consumption of media or completion of digital worksheets, while other students actively engaged in technology through peer collaboration, immersive simulations, media production, interactions with experts, making global connections, design, and coding.

Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, and Sendurur (2012), in discussing research on technology use in the classroom, concluded that technology needed to be "placed in the hands of students," and that they use it "in the same ways, and for the same purposes, that professionals do" to solve problems, communicate, and collaborate (p. 424). However, there is a divide between this imperative and what occurs in many classrooms. After conducting over

140,000 direct K-12 classroom observations, researchers at AdvancED concluded that students were not using technology as a regular part of their learning experience (van Broekhuizen, 2016). They found that more than half of the classrooms observed showed “no evidence of using technology to gather, evaluate or use information for learning,” while two-thirds of the observed classrooms showed “no evidence of students using technology to solve problems, conduct research, or to work collaboratively” (van Broekhuizen, 2016, pp. 4-5).

The gap in technology usage is particularly profound in schools with higher levels of poverty. In a review of literature of 1:1 initiatives in U.S. schools, Schnellert and Keengwe (2012) found that students living in poverty tended to use technology in traditional ways and for remediation activities, while students in affluent communities tended to use technology for analyzing and presenting information to an audience. However, for students at risk, using technology in interactive learning, exploration and creation activities over drill and practice or remedial activities has been shown to be successful in closing some learning gaps (Darling-Hammond, Zielezinski, & Goldman, 2014). Research studies showed that learning was boosted when students engaged in activities that were built on prior knowledge, involved them in active engagement in learning, developed connected knowledge, built content knowledge through collaboration and social interactions, and included self-monitoring of learning with appropriate feedback from the teacher (U.S. Department of Education, 2014). Technology, used effectively, can be a mediator of these learning experiences, and begins with the teacher. As concluded in the National Education Technology Plan update (2017), to fully realize “the benefits of technology in our education system and provide authentic learning experiences, educators need to use technology effectively in their practice” (p. 3)

Teachers and Technology

It has been well established in the literature that the teacher is the main influencer in the type and quality of learning opportunities students experience. An early study of technology use in the classroom, the Apple Classroom of Tomorrow ([ACOT], Apple Computer, Inc., 1995), showed that when students and teachers had unlimited access to technology, not only did student attitudes toward learning, behavior, and attendance all improve, students' competencies in representing dynamic information, social awareness, conf idence, and effective communication increased as well. One of the conclusions by the ACOT report (1995) was that the role of the teacher was key in creating learning environments that were collaborative and inquiry driven, allowing students to actively construct content knowledge using technology (Apple Computer, Inc., 1995). Ertmer (1999) affirmed this conclusion by stating it is the teacher who chooses the specific approaches within their teaching context (Ertmer, 1999). The U.S. Department of Education, in acknowledging that teachers have the biggest impact on student learning, added that it is vital to support teachers with access to technology and help them learn how to use it in the classroom (U.S. Department of Education, 2017).

Research on how teachers implement technology has been completed over several decades. In 2005 Bauer and Kenton followed 30 "tech savvy" teachers in a mixed-method research study that included a teacher survey, researcher classroom observations, and interview data. They found that although the teachers in this study were experienced technology users, they did not integrate technology effectively, with 80 percent of teachers using technology less than half of the time (Bauer & Kenton, 2005). Four areas were identified as hindering effective technology use in this study: 47 percent of teachers had difficulties with equipment, 30 percent cited time as a factor, 23 percent identified student skill level, and 17 percent stated their own skill level was a barrier.

In another study, Gorder (2008) investigated teacher perceptions of technology integration for teachers that attended training for a South Dakota education initiative, *Technology for Teaching and Learning Academy*. In this study, teachers self-reported their own level of techology integration after attending the academy, and identified the technology use as chiefly to deliver content, rather than student use for deeper learning. She also concluded that the teacher was the significant factor for implementation and that professional development opportunities were important to support teacher technology integration in the classroom (Gorder, 2008). Teacher support through professional development was backed up by Ruggiero and Mong (2015). In their mixed-methods study, 1048 teachers were surveyed, followed by interviews of ten percent of the respondents. They found that tech use was pervasive but superficial, with most responses focused on teacher use, such as posting assignments on an interactive white board or using the document camera to demonstrate math problems. The most often used technologies were PowerPoint, film or video, games, and music (Ruggiero & Mong, 2015).

Lim et al. (2013) asserted that the process of technology integration is dynamic, involving many interacting factors over time. They further stated that technology integration is more complicated than just providing computers and internet access. In backing up this conclusion, Delgado, Wardlow, McKnight, and O'Malley (2015) considered why teacher technology use, which has been shown to have a strong, positive effect on student technology use, continued to remain low. They recognized various factors, such as the lack of computer skills for teachers, lack of time for teachers to learn how to use various programs or manage computers, and a lack of resources, including tech support (Delgado et al., 2015). They identified addressing these issues as the first stage in increasing technology use in K-12 classrooms.

Barriers and Perceptions

Early research in the process of teacher technology integration by Ertmer (1999) identified two types of barriers that are obstacles to effective technology integration. First order barriers were those that existed exterior to teachers and referred to available resources, such as equipment, time to learn and implement new technologies, training opportunities, and technical support. Ertmer described these as relatively easy to eliminate through adequate funding (Ertmer, 1999). She further stated that early efforts focused on providing these resources, under the assumption that with adequate resources, technology integration would follow. Research showed that access has increased: just ten years later in 2009, ninety-nine percent of teachers had one or more computers in the classroom or could bring them in to the classroom, and ninety-five percent of those computers had access to the internet (Gray et al., 2010). However, as previously discussed, large-scale technology integration has not followed.

The second type of barrier identified by Ertmer (1999), second-order barriers, refered to teacher underlying beliefs about teaching and learning. These beliefs were described as more difficult to detect, and may not even be apparent to others or the teachers themselves. Because they were more personal, deeply ingrained, and less tangible, they were thought to be more difficult to overcome (Ertmer, 1999). In a later study, Ertmer et al. (2012) noted in a review of 48 empirical studies that while 40% of the studies cited resources as a top barrier, 23% of the studies identified the teachers' knowledge and skills among the top and 13% identified teacher attitude and beliefs as a top barrier.

In their 2012 study, Ertmer et al. examined how aligned the pedagogical beliefs and teaching practices were for 12 teachers nationally recognized for their classroom technology practices. For these teachers, who used technology often as part of the teaching and learning process, their attitudes and beliefs were not a barrier, rather, they became facilitative factors in the teachers' technology practices. When asked what the biggest enabler in their application of technology in the classroom was, five of the twelve attributed internal factors, such as attitudes, beliefs, knowledge, and skills; four cited their own professional learning networks; and three credited the support of administrators (Ertmer et al., 2012). In addition, two of the teachers included student motivation and engagement as an impetus for integrating technology in their classrooms. However, when referring to the biggest barriers these teachers observed in their schools, nine of the twelve pointed to internal, second-order factors of *other* teachers, stating that other teachers were "afraid," "fearful," "intimidated," "leery," or "reluctant" (p. 434) when approached with integrating technology in their practice (Ertmer et al., 2012).

Supporting these findings, Kim, Kim, Lee, Spector, and DeMeester (2013) also studied teacher beliefs and technology integration practices. They followed 22 teachers who had participated in a four-year U.S. Department of Education funded professional development program. Results of this study showed that teacher epistemological beliefs about knowledge and learning were related to their beliefs about effective teaching, as well as their technology integration practices (Kim et al., 2013). They concluded that teacher beliefs should be considered when implementing technology integration programs.

One theory on how innovations move through a population was first published in 1962 by Everett Rogers in a book titled *Diffusion of Innovations,* now in its fifth edition (Rogers, 2003). In it, Rogers identified the condition needed for the acceptance of any new innovation or technology: for it to become self-sustaining, the new technology must reach wide adoption among members of the social group, which, for schools, include teachers, administrators, and district leaders. For the technology-enabled classroom, teacher adoption of technology included becoming adept at a variety of approaches that support content delivery, learner support, and assessment (Adams Becker et al., 2016). The 2016 Horizon Report identified this scaling of teaching innovations as one of the difficult challenges to overcome in educational technology.

Hall (2010) pointed out that this theory was proposed for innovations in agriculture, which were more dichotomous in nature in that the social group either did, or did not, use new seed innovations, for example. For innovations in schools, the process is gradual, involving trial and error. He further attested that, for users to become skilled enough to adopt new technologies, it takes time and may even require new infrastructure (Hall, 2010). Moreover, the many decisions involved occur above the teacher level, leaving the teacher out of the process until implementation. In response, Hall created a Concerns Based Adoption Model (CBAM) that placed the assumption of change as a process within the model (Hall, 2010). The CBAM proposed that integration of new technologies involved an implementation bridge composed of three constructs: levels of use, innovation configuration, and the affective construct of stages of concern. Lim et al. (2013) lent support to a more encompassing view of technology as an innovation by stating that it "is not independent and isolated; it is situated in the ecological system of the school and connected to its broader systems," and often required "simultaneous innovations in pedagogy, curriculum, assessment, and school organization" (p. 62, citing Dede, 1998). However, they concluded that schools have remained largely constant in their approach to technology, with few schools becoming either more efficient in operations or more effective in enhancing learning outcomes.

Clark and Zagarell (2012) took this point further by stating that there is a fundamental struggle between the culture of the school system and the implementation of new technologies.

They described the process of technology integration in education as a complex and “multitiered conundrum” (p. 137). Teachers considered to be digital natives have had more exposure to technology over their lives; however, oftentimes, they have not been exposed to technology integration in the learning process, while other teachers may be intimidated or reluctant to use technology in their classrooms. They concluded that teachers will “continue to use the same methods of teaching they have always used” without effective training (Clark & Zagarell, 2012, p. 138). In suggesting a solution, Ertmer, et al. (2012) added that the “best way to bring more teachers on board is… by increasing knowledge and skills, which, in turn, have the potential to change attitudes and beliefs” (p. 433).

Measuring Perceptions and Practice

Previous assessments of teacher attitudes, beliefs, skills, and knowledge have included various methods and instruments. The Levels of Technology Implementation (LoTi) was developed in 1995 by C. Moersch (Barron et al., 2003). The LoTi was comprised of 50 items that provided a teacher profile over three domains: (1) level of technology integration, (2) personal computer use, and (3) current instructional practices. Morales, Knezek, and Christensen (2008) used the *Technology Proficiency Self-Assessment* (TPSA) questionnaire to study teacher perceptions of their own level of proficiency using several technologies. The TPSA instrument focused on four areas of technology use based on ISTE standards: using e-mail, using the internet, using technology applications, and teaching with technology (Morales et al., 2008). The following year, Liu and Szabo (2009) published the results of a four-year study on teacher attitudes toward technology integration. They used the *Stages of Concern* (SoC) questionnaire developed by Hall et al., which rates respondents’ concern level when using new innovations from *0-Awareness*, or showing little, if any, concern, to level *6-Refocussing*, or exploring the universal benefits of the innovation. More recently, Ertmer et al. (2012) used interviews to determine teacher self- and school-wide perceptions in their case study of award-winning teachers, and Howard and Gigliotti (2016) used a mixed method approach of online questionnaires and in-depth case studies in their four-year investigation of risk-taking experiences when integrating technology.

The Florida Center for Instructional Technology (n.d.) at the University of South Florida created a more comprehensive survey, the *Technology Uses and Perceptions Survey* (TUPS). This instrument was comprised of 200 questions, divided into seven domains: (1) Technology Access & Support, (2) Preparation for Technology Use, (3) Perceptions of Technology Use, (4) Confidence and Comfort Using Technology, (5) Technology Integration, (6) Teacher & Student Use of Technology, and (7) Technology Skills & Usefulness. It was based on the ISTE standards, formerly called the NETS, and expanded from an original survey of four domains: integration; support; preparation, confidence, and comfort; and attitude toward computer use (Barron et al., 2003). The updated TUPS instrument was used in this investigation and is discussed in more detail in the next chapter.

Teacher technology integration in the classroom has also been determined through various methods. One of the earliest projects was started in 1985, the *Apple Classroom of Tomorrow* (ACOT), and used classroom observations, use logs, teacher journals, and regular reports to study the process of technology integration and adoption of technology (Barron et al., 2003). Ertmer et al. (2012) completed a detail document analysis of teacher websites as well as teacher interviews to determine the level of technology integration, while Schnellert and Keengwe (2012) explored technology integration through a literature review. In addition, several models of technology integration have been used to guide teachers and administrators in this process. The TPACK model, introduced in 2009, considered the interaction of three bodies of teacher knowledge, technology, pedagogy, and content knowledge, that is required for the successful integration of technology in teaching (Koehler, Mishra, & Cain, 2013). Lin, Wang, and Lin (2012) presented a similar model, *Pedagogy * Technology* to measure how teachers progress through integration, with the goal to move them to higher levels. This model included four levels for the pedagogy dimension, and eight levels of technology, from non-use to implementation of sophisticated instructional applications. The SAMR model divided technology integration into four levels, *Substitution*, *Augmentation, Modification, and Redefinition* (Puentedura, 2012). Substitution and augmentation essentially focus on the traditional use of technology, while modification and redefinition represent learning tasks with progressively deeper use of technology.

A chief criticism of several methods of determining a level of technology integration is the lack of consideration of the context of the learning environment. For example, Hamilton, Rosenberg, and Akcaoglu (2016) asserted that absence of context and the hierarchical nature of SAMR overlooks the complexity and variety inherit in learning tasks. One framework of technology integration that incorporated the classroom environment directly in its model is the *Technology Integration Matrix* (TIM), developed by FCIT. The TIM is a five-by-five grid, consisting of five classroom environments (*active*, *collaborative*, *constructive*, *authentic*, and *goal-directed)* and five levels of technology integration focused on the pedagogy of the lesson, (*Entry*, *Adoption*, *Adaptation*, *Infusion*, and *Transformation;* see Figure 2) (Florida Center for Instructional Technology, n.d.). The learning environments are not hierarchical; rather, they represent characteristics of meaningful learning contexts for specific lessons (Harmes et al., 2016). It is important to note that, although the levels of technology integration increase as one moves from left to right, there is no specific "idealized" place for teachers to strive to achieve (Dr. James Welsh, personal communication, May 26, 2016). A teacher may be at different levels at different times, depending on the pedagogy of the lesson. However, as the teacher becomes more adept at using technology in teaching and learning, his or her overall technology

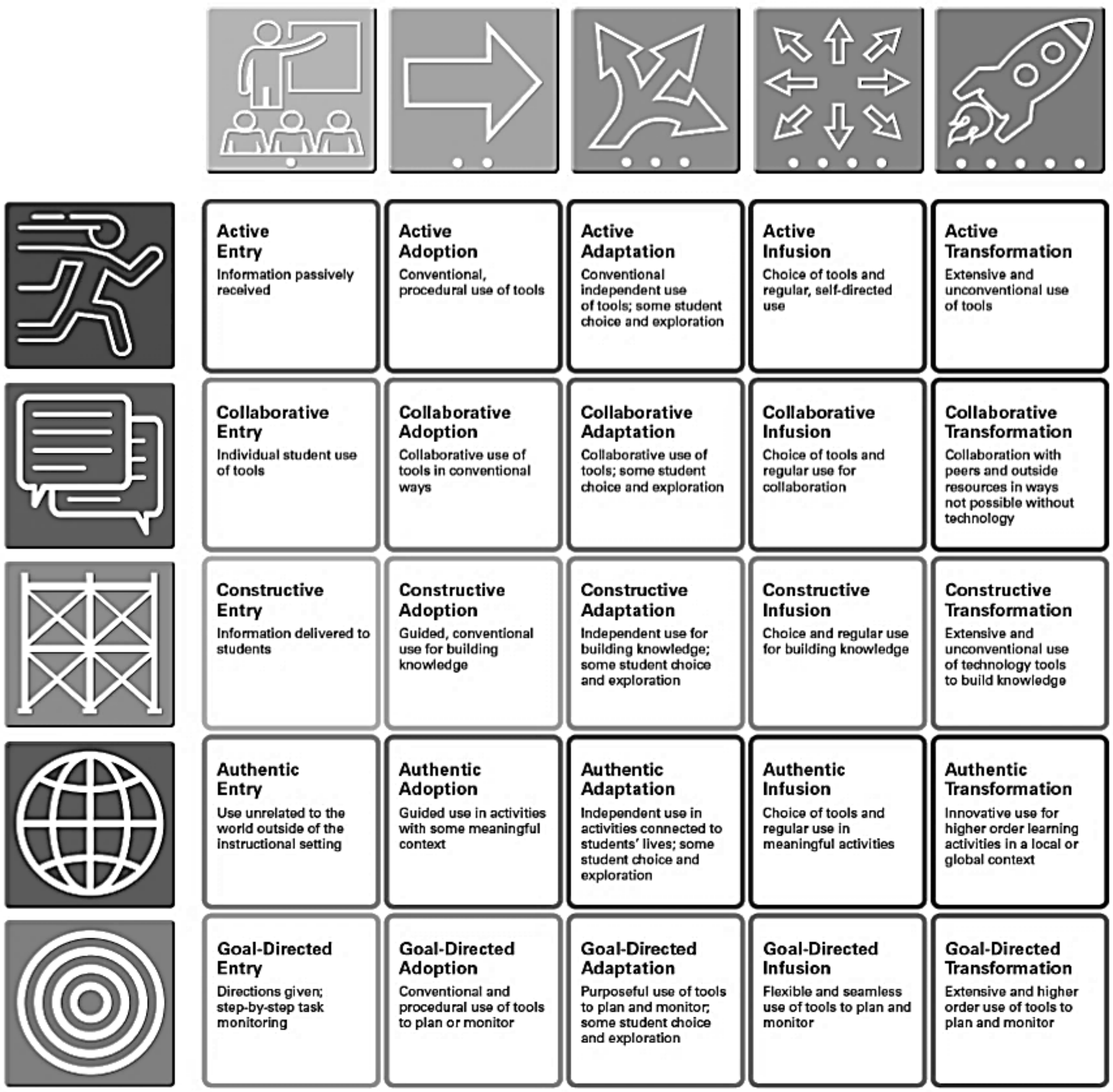


Figure 2. The *Technology Integration Matrix*, from mytechmatrix.org. Graphic from the TIM graphics collection used under free classroom license. Retrieved from https://fcit.usf.edu/matrix/resources/tim-graphics.

integration level should also increase. As of this writing, the state of Florida currently requires school districts to report the overall teacher technology integration levels as described by the TIM, therefore, teacher practice for this study was reported using this tool.

Educational Technology in Florida

From the U.S. Department of Education Strategic Plan to individual state Departments of Education, numerous initiatives have been enacted to improve student access, quality of learning experiences with technology, and teacher professional development with regard to technology integration. Beginning in the 2014-2015 school year, the state of Florida launched a five-year plan to create digital classrooms throughout the state (Florida Department of Education, 2015). This Digital Classroom Plan (DCP) detailed how technology would be integrated into teaching and learning, with the focus of improving student outcomes and empowering students to become digital learners. The five components each district was required to address in their plan were: student performance outcomes, digital learning and infrastructure, professional development, digital tools, and online assessment support. For the first year, the Florida legislation funded the DCP with $40 million, allocating a base amount of $250,000, plus an additional percentage determined by district student enrollment for each approved school district plan (Florida Department of Education, 2015). During the 2014-2015 school year, the allocation of funds statewide was divided as follows: 28% was spent on improving infrastructure, 28% for digital tools, 22% on assessments, and 22% was spent on teacher professional development (Florida Department of Education, 2015). In assessing the use of technology in the classroom, the DCP required each district to report the overall percentage of teachers within each level of technology integration as described by the Florida Center for Instructional Technology's (FCIT) *Technology Integration Matrix.*

Summary

Educational technology has been a part of the educational landscape for more than three decades, yet its full promise is yet to be realized (U.S. Department of Education, 2014). Clark and Zagarell (2012) stated that “the only way to bridge the technological divide is to understand which problems teachers face and how these problems affect their attitude toward technology” (p. 137). To develop this understanding, this chapter reviewed educational technology in the United States and Florida, how technology is used in personal and educational settings, the connection between deeper learning and technology, the technology usage divide present in schools, teacher perceptions about technology, and the role of the TIM in supporting technology integration efforts.

Research studies have sought insight into this issue. Although not addressed in this chapter, many studies focused on the experience, beliefs, or perceptions of pre-service teachers. Of the research involving in-service teachers and discussed in this literature review, most involved teacher self-reported data on the level of technology integration in the classroom or indirect observation though teacher published materials. This study adds to the body of research on technology integration, and expands it to include both teacher insight on their perceptions of technology use, along with independent measures of the technology integration level during specific lessons. Further, this study examined the relationship between the various perceptions, how they relate to the level of technology integration, and whether perceptions predict the technology integration level. This study builds on the current understanding of underlying factors in technology integration and looks at the predictive value of teacher perceptions for technology integration, which has not been reported in the literature. In the next chapter, the research methodology for this study will be described.

III. METHODOLOGY

The purpose of this study was to examine the relationship between teacher perceptions of technology use and observed technology integration in the classroom. In addition, this study sought to determine if teacher perceptions predicted technology integration levels, and which of the seven perceptions represented the most robust predictor of technology integration. This chapter will discuss the research methodology of this study, describe the participants and selection criteria, explain the instruments used and validity measures, and provide an explanation of the statistical procedures used to analyze the data.

Research Methodology

This study employed a quantitative research methodology; specifically, it was a correlational-predictive study. Correlational research is undertaken to determine whether a relationship between variables exists, to what extent the variables are related, or to gain insight into the factors that are related to a complex variable (Gay et al., 2012). As previously discussed, the degree to which teachers integrate technology into their practice, and the factors that influence technology use with students, is multi-tiered and complex; studying the relationship between these factors aids to explicate this complex issue (Ertmer, 2009; Ertmer, et. al, 2012; Thompson, 2013; Rasmussen, 2015; and Zur & Zur, 2016). Further, Gay et al. (2012) cite an additional purpose in conducting correlational studies is to use the relationship between variables to make predictions. They state, “If two variables are highly related, scores on one variable can be used to predict scores on the other variable" (p. 212). However, it is important to note that correlational research does not indicate causation between variables; rather, a high correlation simply suggests a stronger relationship between the variables (Gay et al., 2012).

Research Problem and Purpose

This study examined teacher perceptions of technology and the observed level of technology integration during classroom lessons. Previous studies have largely focused on pre-service teachers or relied on teacher self-reported data on classroom technology integration levels. This study is centered on in-service teachers who were surveyed to determine their personal perceptions of technology, while independent observers scored the teacher technology integration level of specific lessons. In addition, the predictive ability of teacher perceptions has not been studied in relation to enacted teacher technology practices.

The purpose of this study was to determine the relationship between seven areas of teacher technology perceptions and the observed level of teacher technology integration: Entry, Adoption, Adaptation, Infusion, or Transformation. Furthermore, as a predictive study, this study sought to determine the extent that teacher perceptions can be used to predict the technology integration level. Finally, the seven areas of perceptions were disaggregated to determine the relationship and predictive ability of each perception area on the teacher's technology integration level.

Research Questions and Hypotheses

This study was a correlational-predictive study that focused on teacher perceptions and level of technology integration in the classroom. As such, the primary research question was: What is the relationship between teacher perceptions of technology use as measured by the

Technology Uses and Perceptions Survey (TUPS) and teacher technology integration level as measured by the *Technology Integration Matrix- Observation Tool* (TIM-O)?

Three sub-questions were examined to answer the primary research question:

1) What are the relationships between each of the seven areas of teacher perceptions and teacher level of technology integration on the TIM?
2) Does the TUPS represent a significant predictor of TIM level as measured by the TIM-O?
3) Which of the seven areas of the TUPS represents the most robust predictor of teacher technology integration level?

Hypotheses:

1) Hypotheses for the primary research question:

   H_0: There is no statistically significant correlation between teacher perceptions of technology use and the teacher technology integration level in the classroom.

   H_A: There is a strong, statistically significant, positive correlation between teacher perceptions of technology use and the technology integration level in the classroom.

2) Hypotheses for sub-question one:

   H_0: There is no statistically significant correlation between each area of teacher perceptions of technology use and the technology integration level in the classroom.

   H_A: There is a statistically significant, positive correlation between each area of teacher perceptions of technology use and the technology integration level in the classroom, with teacher confidence and comfort level having the most robust correlation.

3) Hypotheses for sub-question two:

   H_0: The TUPS is not a statistically significant predictor of technology integration level in the classroom.

H_A: The TUPS is a statistically significant predictor of technology integration level in the classroom.

4) Hypothesis for sub-question three:

   H_0: None of the seven areas of the TUPS represents a statistically significant predictor of technology integration level in the classroom.

   H_A: Of the seven areas of the TUPS, teacher confidence and comfort level represents the most robust, statistically significant predictor of technology integration level in the classroom.

Data Collection

This study used teacher and district data previously collected by FCIT. The state of Florida allows access to district data, provided that it is de-identified prior to release (J. Welsh, personal communication, March 6, 2017). Once the data were anonymized, FCIT requested and obtained permission to release the data to the researcher. Data previously collected are considered to be secondary data, rather than primary data directly collected by the researcher. Historical research supports the use of secondary data: census data were used in research in the social sciences and to study urban poverty at the turn of the 20^{th} c entury; and in attitudinal surveys before the start of the second world war (Smith, 2008). Gorard (2002) discussed several reasons and advantages to use secondary data, such as the investigation and replication of previous studies as well as increased speed and reduced cost of research. In addition, data sets that are large, collected over many years, and by recognized institutions may bring a level of authority (Gorard, 2002). The use of secondary data in educational research is an acceptable methodology within research, as seen by the routine use of data from national and international sources, such as the Programme for International Student Assessment (PISA) and the National

Center for Educational Statistics (NCES) to establish student baseline and trends over time (Smith, 2008).

Participants

The population under study were K-12 classroom teachers in Florida. In the school year 2015-2016, the total population of teachers in Florida was comprised of 194,519 teachers, who worked with 2,792,234 students (Florida Department of Education, 2017). Of the student population, 58.7% were economically disadvantaged, 13.2 % of the students had disabilities, and 9.8% of the students were English Language Learners (Florida Department of Education, 2017). For the sample, the Florida Center for Instructional Technology (FCIT) provided de-identified, anonymized data files from one school district in Florida (J. Welsh, personal communication, March 6, 2017). To anonymize the data, a randomizer was applied to the Excel files, replacing the teacher, school, and observer names with numbers. The same numerical identifier was applied to each data set, ensuring that the data remained paired. The unique identifier was random and did not refer to any identifiable information, such as an employee number.

Information provided by FCIT was that the school district was large, with over 150,000 students, and comprised of more than 150 public and public charter schools. This district used the TUPS to collect 345 teacher responses during the school years 2015-2016 and 2016-2017 as a part of its technology initiatives. In addition, administrators and district personnel used the TIM-O during the same school years to evaluate individual teacher technology integration levels during classroom instruction. As of March, 2017, the total number of observations recorded over the two school years was 817 observations, with some teachers observed multiple times. To standardize the observations, only the highest recorded TIM level for each teacher was used, as that represented the teacher technology level potential. When multiples were removed, 574 unique observations remained in the data set.

The sample used for analysis was determined by matching the TUPS and TIM-O data by participant. As a correlational-predictive study, it was important to include only participants with both perception responses and observed technology level scores. The data files were combined, then ordered by participant number, and entries that did not contain both TUPS and TIM-O data were removed. The sample used in this study included 51 teachers with paired TUPS and TIM-O data, and had varied teaching experiences ranging from 2-37 years, across grades 1-12, and in ten different subject areas. This sample represented a purposive sample of teachers having both sets of data. Purposive sampling is used when the researcher deliberately identifies specific criteria in the selection of the sample (Gay et al., 2012). In this case, the criteria for selection were teachers that completed the TUPS and were observed by an outside observer using the TIM-O. For correlational research, the minimum sample size is 30 participants (Gay et al., 2012; Field, 2013), therefore the sample side of 51 participants was approved for this study.

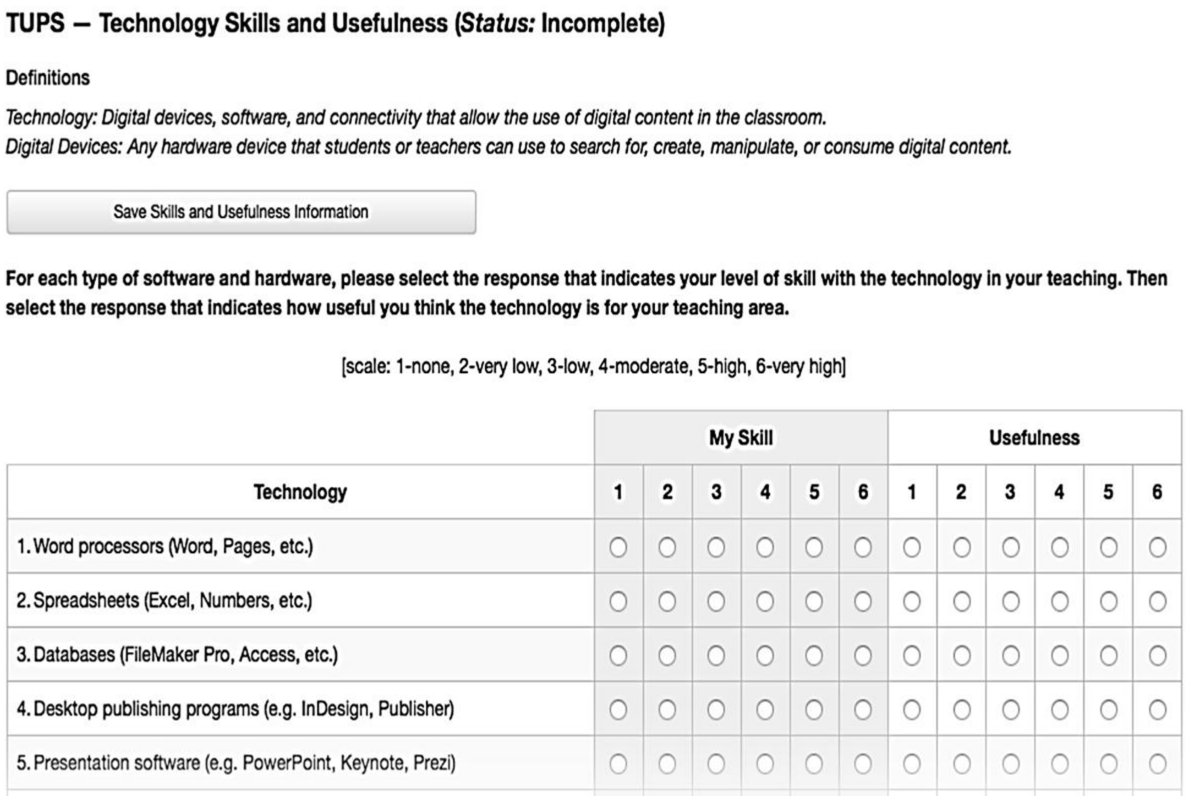
Measures

***Technology Uses and Perceptions Survey* (TUPS).** The TUPS is a 200-question survey covering seven areas of perceptions and technology use in the classroom. In addition to demographic information, the seven areas included are: technology access and support, preparation for technology use, perceptions of technology use, confidence and comfort using technology, technology integration, teacher and student use of technology, and technology skills and usefulness (Florida Center for Instructional Technology, n.d.). As described on the FCIT TIM Tools website, mytechmatrix.org,

> "The TUPS looks at what teachers believe about the role of technology in the classroom, as well as their comfort and confidence with technology in general, with pedagogy of technology, with a variety of different specific technologies, and it also asks about the frequency that they use those technologies and the frequency with which their students use those technologies" (Florida Center for Instructional Technology, n.d.).

Although it is lengthy at 200 questions, the questions in the TUPS are written in a response-grid format. The website FAQ's section reported that most respondents can complete the TUPS in approximately 30 minutes or less, or complete it in sections, as the option to save one's progress is available throughout (Florida Center for Instructional Technology, n.d.). Within each section, there are question stems with a user rating scale. As published on mytechmatrix.org, an example from the "Technology Skills and Usefulness" section includes different types of technology, with two rating scales, one for the teacher skill level and the other for his or her perception of usefulness as rated on a low to high scale: *1-none*, *2-very low*, *3-low*, *4-moderate*, *5-high*, and *6-very high* (Florida Center for Instructional Technology, n.d.). Other scales used on the survey included frequency (not at all to multiple times per day), agreement (strongly disagree to strongly agree), and extent (not at all to entirely).

The TUPS was developed through a process of determining the domains to be included, item construction, pilot testing with graduate students, and large-scale field testing (Hogarty et al., 2003). It was then validated in both paper and web-based formats. Hogarty et al. (2003) used common factor analysis to determine if each section measured only one dimension and calculated *Cronbach's Alpha* on each factor score to investigate reliability of the scores. They found that each section had levels of reliability between .74 to .92, which indicated a strong level of reliability (Field, 2013).



TUPS — Technology Skills and Usefulness (*Status:* Incomplete)

Definitions

Technology: Digital devices, software, and connectivity that allow the use of digital content in the classroom.
Digital Devices: Any hardware device that students or teachers can use to search for, create, manipulate, or consume digital content.

Save Skills and Usefulness Information

For each type of software and hardware, please select the response that indicates your level of skill with the technology in your teaching. Then select the response that indicates how useful you think the technology is for your teaching area.

[scale: 1-none, 2-very low, 3-low, 4-moderate, 5-high, 6-very high]

	My Skill						Usefulness					
Technology	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
1. Word processors (Word, Pages, etc.)	○	○	○	○	○	○	○	○	○	○	○	○
2. Spreadsheets (Excel, Numbers, etc.)	○	○	○	○	○	○	○	○	○	○	○	○
3. Databases (FileMaker Pro, Access, etc.)	○	○	○	○	○	○	○	○	○	○	○	○
4. Desktop publishing programs (e.g. InDesign, Publisher)	○	○	○	○	○	○	○	○	○	○	○	○
5. Presentation software (e.g. PowerPoint, Keynote, Prezi)	○	○	○	○	○	○	○	○	○	○	○	○

Figure 3. TUPS sample section: Technology and Usefulness. This excerpt from the TUPS was published on the mytechmatrix.org website. In this example, the teacher rates his or her skill level in each technology, as well as the perceived usefulness of the technology for the respondent's content area.

Barron et al. (2003) further used the four domains of the original perception survey to study teachers' use of technology in the classroom as related to the International Society of Technology Education NETS guidelines. The four domains chosen were: technology integration; support; preparation, confidence, and comfort; and attitude toward computer use. This instrument was reviewed by experts in technology and measurement, pilot tested, followed by applying minor revisions before distributing to the teachers in the study in paper or Web-based format (Barron et al., 2003). They found the reliability of these domains using *Cronbach's*

Alpha as .89 for the paper version and .87 for the Web version, which also indicated strong reliability (Field, 2013).

Technology Integration Matrix Observation Tool **(TIM-O):** The TIM-O is a Web-based tool that can be used to evaluate the level of technology integration within a specific lesson (Florida Center for Instructional Technology, n.d.). It uses branching questions to guide the observer to identify the technology integration level based on the TIM teacher, student, and instructional setting descriptors. As described by FCIT, the use of skip-logic questions based on observable elements during the lesson brings consistent identification of TIM level, regardless of the observer's familiarity with the TIM (Florida Center for Instructional Technology, n.d.).

In developing the TIM, experts evaluated each phase through field testing using purposeful sampling (Allsopp et al., 2007). The data included a survey of experts in instructional technology (IT) solicited in August 2005; feedback from the Florida Council of Instructional Technology Leaders (FCITL) professors of IT and school district IT directors in September 2005; feedback from K-12 and higher education experts and professors of IT in the areas of childhood education, reading, special education, public school IT coordinators, media specialists, and public school teachers between September 2005 and June 2006; and reviewed by the Florida Department of Education Matrix Advisory Meeting at the Florida Educational Technology Conference (FETC) in March 2006 and January 2007. The comments and feedback from reviewers were coded and were used to revise the TIM (Allsopp et al., 2007).

Barbour (2014) investigated the TIM in relation to student engagement in technology centered classes and non-technology centered classes. He found that there was a positive correlation between technology integration, as measured with the TIM, and student engagement, as measured by the Class Map Survey instrument, with a Pearson coefficient of .69 for the technology centered courses and .67 for the non-technology centered courses.

TIM-O → Question-Based Observation

Teacher Name:

Email Address:

Lesson Date:

We recommend that you observe the lesson for five to ten minutes before answering any questions. The question-based review uses skip logic and it is not possible to go back and change the answer to an earlier question. The sequence of questions that you see is based on your responses to previous questions.

After completing the question-based review you will be presented with a completed matrix. At that time, you will be able to adjust the results of the review based on holistic considerations that may have been missed in the question sequence.

Are the students using technology to do any of the following? (Select all that apply)

- ☐ Setting goals
- ☐ Planning
- ☐ Monitoring progress
- ☐ Evaluating and reflecting on outcomes
- ☐ None of these

Next Question

Figure 4. TIM-O question-based observation sample question. This is an example of a TIM-O skip-logic branching observation question as published on the mytechmatrix.org website. The next question will be populated depending on the observer's response.

Procedures

Once the school district data were de-identified, provided by the FCIT, and paired, descriptive statistics were calculated for the sample using IBM's SPSS data analysis program. Demographic data collected included the teachers' gender, years of teaching experience, subject area(s) taught, average number of students per class, years of using technology for instruction, and grade levels currently taught. This demographic data was correlated to the TUPS results and TIM-O observational data to determine the extent that teacher demographics relate to technology perceptions and technology integration level. In addition, a summary of teacher TIM levels, responses of their perceptions of technology integration from the TUPS, and types of professional development they find most beneficial was reported (see Appendix B).

To answer the research questions, correlational analysis was completed using IBM's SPSS software. Field (2013) identified correlational studies as a measure of effect size, which is an objective measure of the magnitude of an observed effect and uses the measure of Pearson's Correlation Coefficient, *r*. For the analysis, composite scores for selected items in the TUPS sections were compiled and correlated with the highest TIM level recorded during an observation. FCIT suggested using the "high water mark" over a composite score as that represents the teachers' highest level of technology integration during the observed lesson (J. Welsh, personal communication, March 10, 2017).

Through further discussion of the TUPS instrument with FCIT, some sections of the survey lead to meaningful composite scores, while others did not (J. Welsh, personal communication, March 10, 2017). A thoughtful consideration of each prompt resulted in the modification of how each composite score was determined, and whether a composite score was appropriate. For each section of the TUPS, the following guidelines were used to identify the inclusion, exclusion, or grouping of variables: the item directly related to school or district activities; the item directly related to student activities; or, in the case of specific technologies, the level of use as based on deeper learning and 21st century skills development. For each section, the specific determination of use or grouping of variables is delineated below.

Technology Access and Support. For this section, teachers reported the level of access of one-to-one devices available to students, the number of part-time and full-time technology specialists, and the amount of agreement for statements related to technology specialist support opportunities on the teachers' campus. A composite score was determined for only the amount of agreement for the technology specialist support items as those items related to teacher perceptions of the quality of support available. The remaining items were removed from the analysis as the type of student access to devices was outside the topic of this study and the number of technology specialists may or may not relate to the quality of support.

Preparation for Technology Use. Of the six opportunities where teachers reported learning technology skills, only one, "In-service courses or workshops," was directly related to school or district preparation activities. The remaining five opportunities were related to individual pursuits, such as through college or distance learning, or through friends and colleagues. The choice to include only school or district courses and workshops was made to reflect only the learning opportunities meeting teacher professional development needs offered by the school district.

Perceptions of Technology Use. In this section, teachers rated their level of agreement of 12 different areas of technology use in the classroom. A composite score for items 1, 2, 3, 9, 10, 11, and 12 was calculated. These items most strongly aligned to student use of technology, such as "I would like every student in my class(es) to have access to digital devices," and "Technology skills are essential to my students' success in school." The items eliminated related to teacher use, for instance, improving the teacher's job, enhancing teaching, or helping others to solve technology issues. As this study focused on increased depth of student use of technology, only those items related to perceptions of technology use by students were included in the composite variable.

Confidence and Comfort Using Technology. This section included eleven statements in which teachers reported their degree of agreement. Statements one, two, and five were eliminated from the composite score, as they related to access to training opportunities or guiding other teachers in technology integration. The remaining eight items, score numbers 3, 4, 6, 7, 8, 9, 10, and 11, reflected teacher confidence or comfort when using technology in the classroom, from feeling prepared to integrate technology and recognizing unethical uses, to being comfortable using and assigning technology.

Technology Integration. Sixteen items were included in this section, in which teachers rated the frequency of use of technology across various teaching modes. The composite score created included only those modes that reflect student deeper learning and 21st century skills, such as student communication, research, presentations, or creating online content. These were items 8, 9, 11, 12, and 15. The items removed involved the type of grouping, from individual to cooperative groups, the use of technology as a reward or remediation, or technology as a tool for teacher productivity.

Teacher and Student Use of Technology. For this section, the frequency of use of 32 technologies for school activities by the teacher and by the student were reported. For the purposes of this study, nine items were removed as equipment, with the remaining technologies divided into three categories, *Basic*, *Intermediate*, and *Advanced*. These categories were created based on type of usage from conventional to unconventional, following the terms used in the TIM level descriptors (Florida Center for Instructional Technology, n.d.) and reflecting deeper learning applications of technology. The *Basic* category included five technologies that represented the most conventional use of technology, such as email, word processing, drill and practice, tutorials, or accessing a Web browser. The *Intermediate* category included technologies falling between conventional and unconventional. The seven items in this category were concept mapping, presentation software, spreadsheets, data bases, instructional games, draw and paint, and using a learning management system. Finally, the *Advanced* category included digital technologies with unconventional uses or offering students skill building in advanced 21st century skills. Eleven items were placed under the category *Advanced*: desktop publishing; web publishing; photo, sound, and video editing; authoring tools; animation; video conferencing; simulations; social networking; and Web 2.0 technologies, such as blogs and wikis. An initial analysis was considered following these categories, however, studying the level of technology use did not align with the stated research questions. The final composite score comprised the 23 non-equipment technologies, regardless of the level of use.

Technology Skills and Usefulness. This final category included the same 32 technologies as the previous category, therefore the technologies were divided into the same groups. For this section, the teacher rated his or her level of skill and perceived usefulness of each technology on a scale from none to very high. For the analyses, a composite score of the 23 non-equipment technologies was created. Teacher perceptions of usefulness by technology level were compiled and included in Appendix B.

Statistical analysis. For the primary research question, "What is the overall relationship between teacher perceptions and technology integration levels," and sub-question one, "What are the relationships between each of the seven areas of teacher perceptions and teacher level of technology on the TIM," a correlational analysis was completed to establish the relationship between the variables using regression modeling. Field (2013) described different types of regression analysis: simple linear regression, used when there is one independent variable, and multiple regression, used when there is more than one independent variable. In this study, the teacher perceptions of technology as measured by the TUPS was the independent variable and the technology integration level, measured by the TIM-O, was the dependent variable. After graphing a composite TUPS and TIM level score for each teacher, the overall relationship was analyzed through simple linear regression. The TUPS data were disaggregated into the seven areas of technology perceptions and correlated with the teacher's TIM level through multiple regression.

The data were further analyzed to determine the extent that teacher perceptions predict the level of technology integration. In prediction studies, one variable, the independent variable or predictor, can be used to predict the score, or level, of the dependent variable, called the criterion, in an effort to determine which of predictors are most highly related to the criterion (Gay et al., 2012). To answer sub-question two, "Does the TUPS represent a significant predictor of TIM level as measured by the TIM-O," linear regression was used, while multiple regression was used to answer sub-question three, "Which of the seven areas of the TUPS represents the most robust predictor of teacher technology integration level?" Finally, demographic data were used in the analyses to determine the between-subject variables relationship and predictive value between the TUPS and the TIM-O.

Summary

In this chapter, the methodology of this study was described. The purpose of this study was to determine the relationship between teacher perceptions of technology use and level of technology integration in the classroom. In addition, this study sought to determine which of the seven areas of perception represented the most robust predictor of technology integration level. The study participants included 51 K-12 educators from a school district in Florida who completed a user perceptions survey, the TUPS, and were also observed by school administrators or district personnel who scored their level of technology integration using the TIM-O tool. Data were collected in the respective school district throughout the 2015-2016 and 2016-2017 school years and retained at the Florida Center for Instructional Technology (FCIT) at the University of South Florida. Permission to use anonymized teacher and district data was granted by the Florida Department of Education, and provided to the researcher by FCIT.

The data were analyzed using SPSS. Descriptive statistics were calculated for teacher demographic data and were correlated to the TIM-O observational data to determine the relationship between teacher demographic areas and observed technology integration level. To answer the research questions, linear regression was used to determine the overall relationship between perceptions and technology integration level, and multiple regression was used to determine the relationship between each of the seven areas of perceptions and technology integration level. Finally, an overall prediction model was determined through linear regression, and multiple regression was used to determine which of the seven areas of perception represented the most robust predictor of technology integration level. In the next chapter, the results of the statistical tests will be reported and discussed.

IV. RESULTS

The current investigation was purposed to examine teacher perceptions of technology and technology integration. In advance of addressing the stated research questions in the current investigation, preliminary analyses were conducted. Specifically, an evaluation of missing data, internal consistency of response (reliability), and essential demographic data were conducted with the study's data set.

Preliminary Analyses

Missing Data

The study's data set was completely intact with no missing data points evident in the recorded perceptions and observations of the 51 study participants. Therefore, neither formal missing data analysis using *Expectancy Maximization (EM)* nor *Multiple Imputations (MI)* were deemed necessary.

Internal Consistency of Participant Response (Reliability)

The internal consistency of participant response (reliability) within the TUPS domains is considered 'High" and even approaching "Very High" and at a statistically significant level. The *Cronbach's Alpha* level achieved in participant response to the TUPS items was $a = .73$; $p < .001$. Considering participant grade-level taught, those teaching at the high school level achieved the highest degree of internal consistency ($a = .74$; $p < .001$). Participants with graduate degrees manifested internal consistency at a level slightly higher than participants possessing undergraduate degrees (*a* = .75; *a* = .70). Participants occupying the "White" category of ethnicity manifested the highest level of internal consistency ($a = .79$; $p < .001$) within peer group comparisons. Gender comparisons of internal consistency depicted an equivocally high degree ($a = .72$; $p < .001$) in both female and male participants.

Essential Demographics

The total sample size of study participants was 51. Of the total participants in the study, nearly three in four were female (72.6%). Approximately 6 in 10 participants were "Caucasian" by ethnicity (64.0%). Regarding grade level of professional service, slightly over half were teachers of high school level students (52.9%), with the remaining portion of participants evenly divided between the elementary and middle school levels. Participants were fairly evenly represented in the study when considering level of education by professional degree (47.1% "Graduate Degree;" 52.9% "Undergraduate Degree").

A Priori Power Analysis

A Priori power analysis, using both medium and large effect sizes indicated a sample size range of 21 to 64 would be adequate in detecting treatment effect for associative analyses. For predictive analyses, a sample size of 20 to 43 was considered adequate in detecting a medium to large treatment effect in the study's data set.

Data Analyses by Research Question

In order to address the stated research problem in the current investigation, the following research questions were posed:

Primary Research Question

To what degree do teacher perceptions of technology use as measured by the *Technology Uses and Perceptions Survey* (TUPS) relate to teacher technology integration level as measured by the

Technology Integration Matrix- Observation Tool (TIM-O)?

Hypotheses for the Primary Research Question:

H_0: There is no statistically significant correlation between teacher perceptions of technology use and the teacher technology integration level in the classroom.

H_a: There is a statistically significant, positive correlation between teacher perceptions of technology use and the technology integration level in the classroom.

Data analysis: Primary Research Question

The relationship between teacher perceptions of technology use as measured by the *Technology Uses and Perceptions Survey* (TUPS) and teacher technology integration level as measured by the *Technology Integration Matrix- Observation Tool* (TIM-O) is considered "low-moderate" ($r = .24$). The relationship is, however considered a statistically significant relationship between the two measures ($p < .05$).

The relationship between teacher perceptions of technology use as measured by the TUPS and teacher technology integration level is strongest for teachers at the middle school-level of professional practice ($r = .77$; $p = .003$). Additionally, teachers possessing graduate degrees manifested a moderate relationship between the TUPS and TIM-O values ($r = .37$; $p < .10$).

In light of the statistically significant finding for the Primary Research Question, the Null (H_0) Hypothesis is rejected. The Alternative Hypothesis (H_a) is, however, retained.

Research Sub-Questions

1) What are the relationships between each of the seven areas of teacher perceptions and teacher level of technology integration on the TIM?
2) Does the TUPS represent a significant predictor of TIM level as measured by the TIM-O?

3) Which of the seven areas of the TUPS represents the most robust predictor of teacher technology integration level?

Research Sub-Question #1

What are the relationships between each of the seven areas of teacher perceptions and teacher level of technology?

The following table depicts the degree of relationship between the seven areas or domains of teacher perception (TUPS) and their concomitant level of technology (TIM-O):

Table 1: Degree of Relationship Between TUPS Domains and TIM-O Level.

TUPS Area (Domain)	*r*
Access/Support	.04
Comfort/Confidence	.20
Integration	.18
Perception	.06
Preparation	.18
Teacher/Student Use	.04
Skills/Usefulness	.23

The “Skills/Usefulness” area of TUPS manifested the greatest degree of association with the level of technology use (TIM-O) at r = .23. Within subgroups, the “Skills/Usefulness” area of TUPS manifested the greatest degree of relationship with the TIM-O scale with participants who were teachers of middle-school level students (r = .77; p = .003). Moreover, teachers possessing graduate–level degrees manifested a statistically significant level of relationship between the “Skills/ Usefulness” area of TUPS and the TIM-O Scale (r = .41; p < 05), the only statistically significant relationship noted when TUPS areas/domains and the TIM-O Scale were compared by educational level of study participant. Female participants manifested the highest degree of relationship between TUPS areas/domains and the TIM-O Scale in the area of "Comfort" ($r = .31$; $p < .10$). Regarding participant ethnicity, teachers occupying the "Hispanic" category manifested the greatest degree of relationship between the TUPS "Skills Usefulness" area/domain and the TIM-O Scale ($r = .64$; $p < .10$).

Hypotheses Research Sub-Question #1

H_0: There is no statistically significant correlation between each area of teacher perceptions of technology use and the technology integration level in the classroom.

H_a: There is a statistically significant, positive correlation between each area of teacher perceptions of technology use and the technology integration level in the classroom, with confidence and comfort level having the most robust correlation.

In light of the non-statistically significant findings in each of the comparisons of perceptions of technology use and technology integration, the Null (H_0) Hypothesis is retained for Research Sub-Question #1. The Alternative (H_a) Hypothesis in Research Sub-Question is rejected.

Research Sub-Question #2

Does the TUPS represent a significant predictor of TIM level as measured by the TIM-O?

Using the TUPS Scale of perceptions of technology use, teacher perceptions represented a statistically significant predictor of subsequent technology integration level. The following table illustrates the predictive relationship:

Table 2: The Predictive Relationship Between the TUPS and the TIM-O Level.

Variables	*ß*	*SE*	*Standardized ß*	*t*
Intercept	0.59	0.87		0.68
TUPS Scale	0.44	0.26	.26	1.69*

*$p < .10$

The most robust predictive effect of teacher perceptions and technology use within the grade level of professional practice was evident with teachers of middle school-aged students ($p = .003$). The predictive effect was more significant for teachers possessing graduate degrees ($p < .10$) than that of their peers in the study possessing undergraduate degrees ($p = .49$), and more robust for female study participants ($p < .10$) than for male study participants ($p = .30$). No statistically significant predictive effect was evident in model of teacher perceptions and technology use when the data were analyzed by participant ethnicity.

Hypotheses Research Sub-Question #2

H_0: The TUPS is not a statistically significant predictor of technology integration level in the classroom.

H_a: The TUPS is a statistically significant predictor of technology integration level in the classroom.

Using the more liberal interpretation of the alpha level .10, the Null (H_0) Hypothesis for Research Sub-Question #2 is rejected. However, the Alternative (H_a) Hypothesis for Research Sub-Question #2 is retained.

Research Sub-Question 3

Which of the seven areas of the TUPS represents the most robust predictor of teacher technology integration level?

The following table represents the predictive ability of each of the teacher perception areas/domains measured on the TUPS with regard to teacher technology integration level:

Table 3: The Predictive Ability of Each TUPS Domain on the TIM-O Level.

TUPS Area/Domain	*ß*	*SE*	*t*
Access/Support	0.04	0.15	0.26
Comfort/Confidence	0.28	0.20	1.40
Integration	0.14	0.12	1.25
Perception	0.07	0.17	0.42
Preparation	0.17	0.13	1.29
Teacher/Student Use	0.07	0.25	0.27
Skills/Usefulness	0.23	0.14	1.61

Although none of the seven areas of teacher perceived use of technology represented a statistically significant predictor of concomitant teacher technology integration, interpretation of the respective regression weights (*ß*) and predictive slopes (t) would appear to indicate that both the “Skills/Usefulness” and “Comfort” areas/domains are exerting the most robust predictive effect upon teacher technology integration level.

For participants teaching at the middle school- level, the predictive effect of “Skills/Usefulness” was a statistically significant predictor ($p = .003$) for teacher technology integration level in the classroom. A statistically significant predictive effect was also evident in the TUPS area/domain of “Skills/Usefulness” ($p < .05$) with regard to technology integration level for teachers possessing graduate professional degrees. Using a more liberal alpha level of $p < .10$, teachers possessing graduate degrees manifested a statistically significant predictive effect in the TUPS area/domain of “Comfort/Confidence” with r egard to technology integration level.

Using a more liberal alpha level of $p < .10$, female participants manifested a statistically significant predictive effect in the TUPS area/domain of "Comfort/Confidence" with regard to technology integration level. Participants occupying the ethnicity category of "Hispanic" manifested a statistically significant effect ($p < .10$) in the area/domain of "Skills/Usefulness" with regard to technology integration level.

Hypotheses Research Sub-Question #3

H_0: None of the seven areas of the TUPS represents a statistically significant predictor of technology integration level in the classroom.

H_a: Of the seven areas of the TUPS, teacher confidence and comfort level represents the most robust statistically significant predictor of technology integration level in the classroom.

In light of the non-statistically significant finding, the Null (H_0) Hypothesis is retained in that none of the seven TUPS areas/domains represented statistically significant predictors of teacher technology integration level in the classroom. The Alternative (H_a) Hypothesis in Research Sub-Question #3 is rejected.

Summary

The current investigation was purposed to examine teacher perceptions of technology and technology integration in the classroom. The study's data set was completely intact with no missing data points evident in the recorded perceptions and observations of the 51 study participants. Therefore, formal missing data analysis using *Expectancy Maximization* (EM) and *Multiple Imputations* (MI) were deemed not necessary. The internal consistency of participant response (reliability) within the TUPS domains is considered 'High" and even approaching "Very High" at a statistically significant level.

The relationship between teacher perceptions of technology use as measured by the *Technology Uses and Perceptions Survey* (TUPS) and teacher technology integration level as measured by the *Technology Integration Matrix- Observation* Tool (TIM-O) is considered "low-moderate. The "Skills/Usefulness" area of TUPS manifested the greatest degree of association with the level of technology use (TIMO).

The TUPS Scale of perceptions of technology use represented a statistically significant predictor of subsequent technology integration level. However, none of the seven areas of teacher perceived use of technology represented a statistically significant predictor of concomitant teacher technology integration. Interpretation of the respective regression weights and predictive slopes would appear to indicate that both the "Skills/Usefulness" and "Confidence/Comfort" areas/domains are exerting the most robust predictive effect upon teacher technology integration level.

The between subjects variables of "teachers of middle school students" and "teachers possessing graduate-level university degrees" appear to have manifested a consistent, statistically significant associative and predictive effect upon technology integration within the stated research questions of the study. The TUPS scales that appear to be the most influential correlates and predictors of participant technology integration score were "Confidence/Comfort," and "Skills/Usefulness."

While this chapter focused on the results of the statistical analyses of this study, the next chapter will discuss the meaning of the results in the larger setting of teacher technology integration. In addition, the context of this study within the current body of research will be considered. Finally, implications and recommendations for further research will be offered.

V. DISCUSSION

The purpose of this study was to examine the relationship between teacher perceptions of technology use and the observed level of technology integration in the classroom. In addition, this study sought to determine if teacher perceptions predicted technology integration level. Through the literature review process, it was evident that a disconnect exists between the stated goals of technology integration in the classroom (see U.S. Department of Education, 2017) and the practices of integrating technology in teaching and learning (see Darling-Hammond, Zielezinski, & Goldman, 2014; van Broekhuizen, 2016). Ertmer (1999) and Ertmer et al. (2012) postulated that second-order barriers to technology integration, referring to internal beliefs and perceptions, are oftentimes the more difficult to overcome, as they are personal, and the teacher may not even be aware of them. As school districts endeavor to increase active and authentic student use of technology, it is important to consider the role of these internal teacher perceptions and how they are related to technology integration practices in the classroom.

To investigate this relationship, two instruments were employed. The *Technology Uses and Perceptions Survey* (TUPS) was used to collect teacher perceptions across seven domains, and the *Technology Integration Matrix- Observation* (TIM-O) tool was used to collect outside observer data of the level of technology integration in the classroom. These instruments are part of the TIM Tools suite of data collection tools created by the Florida Center for Instructional Technology (FCIT) at the University of South Florida. The TIM-O is based on the *Technology*

Integration Matrix (TIM), which is a free, Web-based resource that educators can use to evaluate technology integration during a lesson, view written descriptors of the five levels of technology integration, and consult exemplar videos of each level in action. The State of Florida Department of Education requires the reporting of teacher TIM levels as part of the legislated Digital Classroom Plan initiative and recommends the use of the TIM Tools suite for gathering data at the school district level.

Through collaboration with FCIT, a school district was identified as having collected both TIM-O and TUPS data. Once the data were paired, 51 participants remained in the sample. Correlational analyses were performed to analyze the relationship between the overall TUPS and the TIM-O, as well as between each section of the TUPS and the TIM-O. Simple linear regression was used to determine the predictive ability of the TUPS on the TIM-O level, and multiple regression was used to ascertain the predictive ability of each domain of the TUPS on the TIM-O level.

Summary of Results

Four research questions were posed in this study, and of them, two had statistically significant findings. The data analysis showed that a positive and significant relationship exists between the overall teacher perceptions and teacher technology integration level, and teacher perceptions as a whole have a predictive ability on the technology integration level. However, when disaggregated into separate perception areas, neither the relationship between the individual TUPS domains and the TIM-O, nor the predictive value of the individual TUPS domains on the TIM-O were statistically significant. The variables were further analyzed by participant sub-groups, revealing additional significant relationships. This discussion will address the study results for each research question as well as interesting findings from the analysis.

When looking at the overall relationship between the teacher perceptions and technology integration level, a low-moderate positive relationship was found. In addition, a strong positive relationship, with an exceptionally high level of statistical significance, was found for teachers of middle school students. A moderately positive relationship existed for the sub-group of teachers with a graduate degree.

No single perception area showed a statistically significant relationship with the technology integration level when disaggregated into the seven areas of perceptions. Although not statistically significant, the greatest degree of association between the TUPS and the TIM-O was positive and in the TUPS domains of skills and usefulness, as well as the comfort and confidence levels. No relationship studied held a negative association with the TIM-O level. Looking at between-subject variables, middle school level teachers had a high degree of relationship for the skills and usefulness scale at a high significance level. Teachers with graduate degrees and of Hispanic ethnicity had a moderate to moderate-strong positive relationship between their skills and usefulness scales and technology integration level, and female teachers had a moderate association between comfort and confidence and technology integration level.

Teacher perceptions as measured by the TUPS was also found to be a statistically significant predictor of technology integration level, as measured by the TIM-O. As in the overall findings, the perception scores for teachers of middle school students had the most robust predictive value, again with a remarkably high level of statistical significance. Furthermore, teachers with graduate degrees and female teachers had TUPS scores with a higher predictive effect on the TIM-O level than their peers.

Finally, when separated into its component areas, no area of the TUPS had a statistically significant predictive value on the TIM-O level. Two areas, the skills and usefulness, and confidence and comfort scales, did have the most robust predictive effect on the technology integration level. Once again, when between subject variables were analyzed, several sub-groups showed significant predictors between perceptions and integration level. For the sub-group of teachers of middle school students, the skills and usefulness scale was a significant predictor at a high level of significance. Hispanic teachers and those with graduate degrees also had a significant predictor for skills and usefulness. In addition, teachers with graduate degrees and female teachers showed comfort and confidence as a significant predictor of technology integration level.

Discussion of findings

In exploring the relationship between teacher perceptions of technology use and the observed technology integration in the classroom, as well as the predictive value of perceptions on technology integration level, a liberal significance level ($p < .10$) was used to determine statistical significance. Although the standard level of significance is ($p < .05$), Gay et al. (2012) allowed for the liberal level of significance when research is exploratory in nature, such as in this study. Several findings made using a more robust level ($p = .003$) were noted in the results and discussion.

Although this study focused on teacher perceptions in relation to their observed technology integration level, when considering the descriptive statistics, several interesting results became apparent (see Appendix B). Consistent with the observations made by Ruggiero and Mong (2015) and Delgado et al. (2015), technology integration for this sample remain on the basic, teacher-centered levels, with 21% of the teachers at entry and 63% at adoption. In addition, while teachers reported that they would like every student to have access to a device and that technology skills are essential for student success, they scored the “technology should be used in all courses,” and “would like students to use technology more in classes” lower on the perceptions survey. This contrasts the National Technology Education Plan (2017), which calls for the inclusion of more technology to help students learn at a deeper level on a daily basis.

The way technology is used is an important consideration, as students must be exposed to higher uses of technology to be prepared for the requirements of future careers. When asked about the usefulness of various technologies, teachers reported a high value to the basic tools, such as email, using a browser, and using word processing; however, a low value of percieved usefulness was given to multimedia rich technologies, such as media editing, authoring tools, web publishing, and animation (see Appendix B). These higher levels of technology use promote creative thinking, problem solving, and oftentimes communication and collaboration, the 21st century skills called for by the U.S. Department of Education (2017) and attributed to closing some of the achievement gap (Darling-Hammond et al., 2014).

The overall relationship between perceptions and technology integration level was statistically significant, low-moderate, and positive, meaning that, as perceptions increase, the level of technology integration also increases. This finding is in line with Kim et al., 2013, who found that teachers’ epistomological beliefs about knowledge and learning were related to their beliefs about teaching and their technology integration practices. It is important to reitterate that correlation does not imply causation; in this study, it cannot be concluded that teacher perceptions cause the level of technology integration, only that the variables are positively related.

A perspective not previously investigated in the literature is the predictive effect of perceptions on the technology integration. In other words, if the teacher's current perceptions are known, could a prediction be made about the level of technology integration enacted by the teacher? At this initial exploration of predictive ability, the data indicated that there was a statistically significant predictive value to the overall TUPS composite score, with a predictive weight of .44. Stated another way, for every one unit increase in TUPS score, there is a predicted increase in TIM-O level by .44 unit. While it cannot be determined from this study that the TUPS score does or does not cause the effect on the TIM-O level, it is worthwhile to be aware of the overall relationship and predictive value knowing the teacher perceptions.

Of particular interest are the statistically significant findings for the between subject variables. Teachers of middle school students had strong, statistically significant findings for the four research questions, and at a exceptionally high level of significance ($p = .003$). When disagregated by teaching assignment, middle school level teachers were the only group with significant findings. It is possible that contextual factors present in the middle school environment led to a stronger and more significant relationship between the variables, such as the presence of learning opportunities that connect theory and practice. As the district information was anonymized, it is impossible to determine why this group stood apart from their peers, but would be a valuable future study.

In addition, teachers with graduate degrees had moderate, statistically significant findings at the liberal level of interpretation ($p < .10$). For this group, it may be that additional exposure to learning experiences at the professional level have brought a stronger alignment of perceptions and enacted practices. Other sub-groups that showed statistically significant findings were female teachers and teachers of the Hispanic ethnicity. For gender, only 14 members of the sample were males, which fell below the *A Priori* sample size test for power, therefore that portion of the sample may not have been large enough to detect an effect. In searching through the literature, teacher perceptions have not been studied in relation to teacher ethnicities.

Implications for Practice

The results of this study speak to practitioners involved with teacher development, such as administrators and professional developers, as well as teachers and other professionals desiring to integrate technology into the process of teaching and learning. Given that a statistically significant relationship exists between perceptions and enacted technology integration practices, explicitly targeting these perceptions is a valuable investment of time. Although the individual perceptions did not show statistically significant relationships, between-subject analysis revealed significant relationships for the skills and usefulness measure and the comfort and confidence measure. This implies that directing professional development to improve these specific perceptions would benefit technology integration efforts.

As a statistically significant predictor of the observed TIM-O level, teacher perceptions as measured by the TUPS could provide an indication of the level of technology integrated lessons occuring in the classroom. This information is useful when planning technology initiatives and professional learning programs. In looking at the individual TUPS domains, although none of the areas individually were statistically significant predictors, the skills and usefulness scale and the comfort and confidence scale were both significant for several sub-groups of educators. Kim et al. (2013) concluded that teacher beliefs should be considered when developing technology integration plans, which was furthered by Delgado et al. (2015), who stated that some of the first issues to address in overcoming low levels of technology integration in education are teacher skills and time to learn the new technologies. By beginning with teacher perceptions, specifically the domains that are significant to the sub-groups, those areas with the strongest predictive power would be addressed. As concluded by Ertmer et al. (2012) increasing teacher technology knowledge and skills has the potential to increase teacher beliefs.

Finally, professional development for teachers in technology integration has been included in technology initiatives for some time. Over thirty years ago, in 1985, Apple Computers began the program *Apple Classroom of Tomorrow*, in which classrooms were provided with devices and training to incorporate technology into teaching and learning (Apple Computer, Inc., 1995). In the state of Florida, a technology professional learning plan has been required as part of the Digital Classroom Plan enacted by the legislature since the 2014-2015 school year. Many other programs have been initiated across the United States. However, as discussed in the literature review and revealed in this sample population, technology use remains at the lower end of the scale, with 84% of the sample occupying the first and second levels of the TIM. It is possible that professional development efforts that consider underlying perceptions may be more effective at implementing these programs.

Study Weaknesses

There were several weaknesses in this study. First, the data accessed were previously collected in a school district outside the control of the researcher. The survey administration and observation protocols were not established prior to the study; rather, the instruments were used as part of the ongoing school district technology and professional development plan, and the data were made available post hoc for this study. While the *A Priori* power analysis revealed that the sample size of 51 participants was within the acceptable range of 21 to 64, it may not have reached the size needed to detect an effect. In addition, although a strength of the study was that the sample was heterogeneous, given the smaller sample size, the number of members for each sub-group may not have been strong enough for analysis. A final weakness was the use of a liberal interpretation of significance ($p < .10$). As previously discussed, though this level is acceptable for exploratory research, a more robust significance level would add strength to the findings.

Recommendations for Future Research

This study supported the body of knowledge related to teacher perceptions of technology use in the classroom, and expanded it to include outside observations of technology use within lessons. In addition, the predictive ability of perceptions was explored to further this field of study. In continuing this study, a larger sample size from multiple school districts would increase its generalizability. Furthermore, given the significant findings with teachers of middle school students, further exploring the dynamic of perceptions by grade level and underlying factors would be valuable. A study into the perceptions and technology integration practices of teachers of different educational levels would add a dimension that would be meaningful in planning teacher preparation and continuing education programs.

As an exploratory study, this study was undertaken as part of the process of developing a grounded theory of teacher access points into technology integration. Given the population of veteran teachers who may have varying levels of comfort, or discomfort, using technology within the context of their teaching specialty, it is vital to consider how they, as the leaders of the classroom, can bridge their own technological divide. Of primary concern is how to help equip these teachers with the skills and resources they need to provide the deeper learning experiences for students that include the rich use of technology. A next step in this line of research may be a phenomenological or mixed-methods study of teacher experiences and mitigating influences on their level of technology integrated into the teaching and learning process.

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APPENDICES

Appendix A

United States Department of Education Strategic Goals and Objectives (2014-2018)

The following are the strategic goals and related objectives for the U.S. Department of Education for fiscal years 2014-2018 (U.S. Department of Education, n.d.):

Goal 1: Postsecondary Education, Career and Technical Education, and Adult Education. Increase college access, affordability, quality, and completion by improving postsecondary education and lifelong learning opportunities for youths and adults.

Strategic Objective 1.1: Access and Affordability. Close the opportunity gap by improving the affordability of and access to college and/or workforce training, especially for underrepresented and/or underprepared populations (e.g., low-income and first-generation students, English learners, individuals with disabilities, adults without high school diplomas, etc.).

Strategic Objective 1.2: Quality. Foster institutional value to ensure that postsecondary education credentials represent effective preparation for students to succeed in the workforce and participate in civic life.

Strategic Objective 1.3: Completion. Increase degree and certificate completion and job placement in high-need and high-skill areas, particularly among underrepresented and/or underprepared populations.

Strategic Objective 1.4: Science, Technology, Engineering, and Mathematics (STEM) Pathways. Increase STEM pathway opportunities that enable access to and completion of postsecondary programs.

Goal 2: Elementary and Secondary Education. Improve the elementary and secondary education system's ability to consistently deliver excellent instruction aligned with rigorous academic standards while providing effective support services to close achievement and opportunity gaps, and ensure all students graduate high school college- and career-ready.

Strategic Objective 2.1: Standards and Assessments. Support implementation of internationally benchmarked college- and career-ready standards, with aligned, valid, and reliable assessments.

Strategic Objective 2.2: Effective Teachers and Strong Leaders. Improve the preparation, recruitment, retention, development, support, evaluation, recognition, and equitable distribution of effective teachers and leaders. States with approved Elementary and Secondary Education Act (ESEA) flexibility requests are required to implement teacher and principal evaluation and support systems by 2014–15 or 2015–16, depending on the school year of initial approval. Under recently announced additional flexibility, personnel decisions based on those systems are not required until 2016–17.

Strategic Objective 2.3: School Climate and Community. Increase the success, safety, and health of students, particularly in high-need schools, and deepen family and community engagement.

Strategic Objective 2.4: Turn Around Schools and Close Achievement Gaps. Accelerate achievement by supporting states and districts in turning around low-performing schools and closing achievement gaps, and developing models of next generation high schools.

Strategic Objective 2.5: STEM Teaching and Learning. Increase the number and quality of STEM teachers and increase opportunities for students to access rich STEM learning experiences.

Goal 3: Early Learning. Improve the health, social-emotional, and cognitive outcomes for all children from birth through 3rd grade, so that all children, particularly those with high needs, are on track for graduating from high school college- and career-ready.

Strategic Objective 3.1: Access to High-Quality Programs and Services. Increase access to high quality early learning programs and comprehensive services, especially for children with high needs.

Strategic Objective 3.2: Effective Workforce. Improve the quality and effectiveness of the early learning workforce so that early childhood educators have the knowledge, skills, and abilities necessary to improve young children's health, social-emotional, and cognitive outcomes.

Strategic Objective 3.3: Measuring Progress, Outcomes, and Readiness. Improve the capacity of states and early learning programs to develop and implement comprehensive early learning assessment systems.

Goal 4: Equity. Increase educational opportunities for underserved students and reduce discrimination so that all students are well-positioned to succeed.

Strategic Objective 4.1: Equitable Educational Opportunities. Increase all students' access to educational opportunities with a focus on closing achievement gaps and remove barriers that students face based on their race, ethnicity, or national origin; sex; sexual orientation or gender identity or expression; disability; English language ability; religion; socioeconomic status; or geographical location.

Strategic Objective 4.2: Civil Rights Compliance. Ensure educational institutions' awareness of and compliance with federal civil rights obligations and enhance the public's knowledge of their civil rights.

Goal 5: Continuous Improvement of the U.S. Education System. Enhance the education system's ability to continuously improve through better and more widespread use of data, research and evaluation, evidence, transparency, innovation, and technology.

Strategic Objective 5.1: Data Systems and Transparency. Facilitate the development of interoperable longitudinal data systems for early learning through employment to enable data driven, transparent decision making by increasing access to timely, reliable, and high-value data.

Strategic Objective 5.2: Privacy. Provide all education stakeholders, from early childhood to adult learning, with technical assistance and guidance to help them protect student privacy while effectively managing and using student information.

Strategic Objective 5.3: Research, Evaluation, and Use of Evidence. Invest in research and evaluation that builds evidence for education improvement; communicate findings effectively; and drive the use of evidence in decision-making by internal and external stakeholders.

Strategic Objective 5.4: Technology and Innovation. Accelerate the development and broad adoption of new, effective programs, processes, and strategies, including education technology.

Goal 6: U.S. Department of Education Capacity. Improve the organizational capacities of the Department to implement this strategic plan.

Strategic Objective 6.1: Effective Workforce. Continue to build a skilled, diverse, and engaged workforce within the Department.

Strategic Objective 6.2: Risk Management. Improve the Department's program efficacy through comprehensive risk management, and grant and contract monitoring.

Strategic Objective 6.3: Implementation and Support. Build Department capacity and systems to support states' and other grantees' implementation of reforms that result in improved outcomes, and keep the public informed of promising practices and new reform initiatives.

Strategic Objective 6.4: Productivity and Performance Management. Improve workforce productivity through information technology enhancements, telework expansion efforts, more effective process performance management systems, and state-of-the-art leadership and knowledge management practices.

Appendix B

Selected Graphs of TIM-O and TUPS Responses

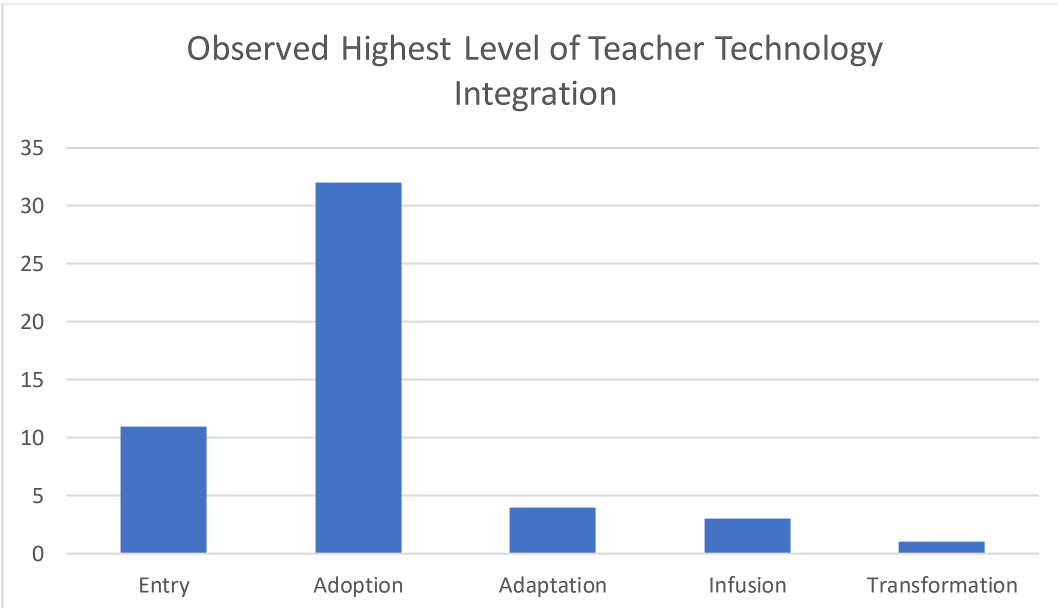

Figure B1: Number of teachers in sample at each observed TIM level.

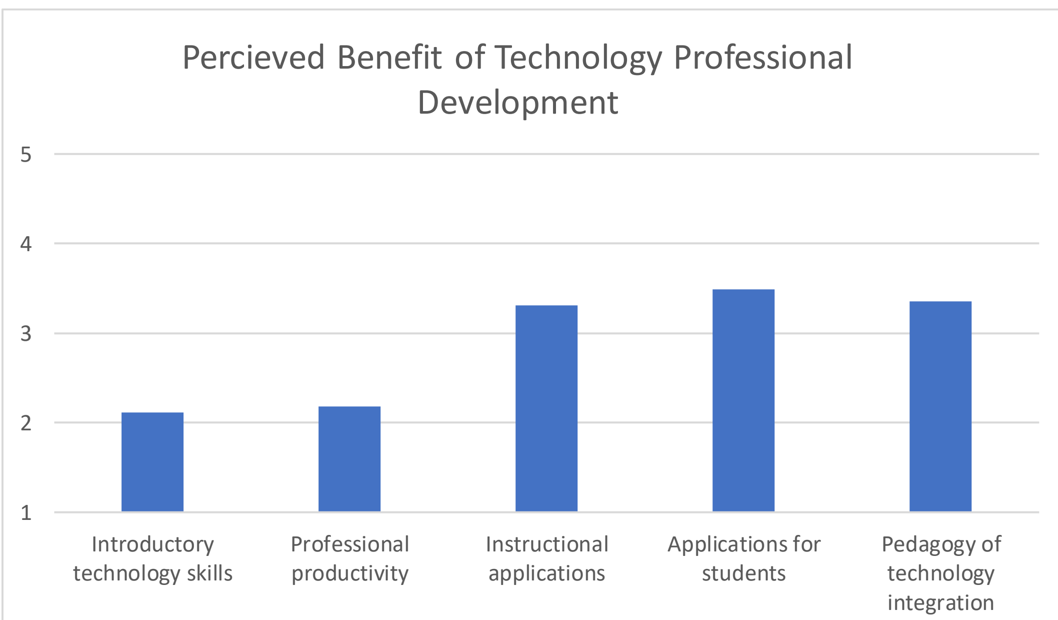

Figure B2: Average level of perceived benefit of each technology professional development type. Scale used: extent (1= Not at all; 5=Entirely)

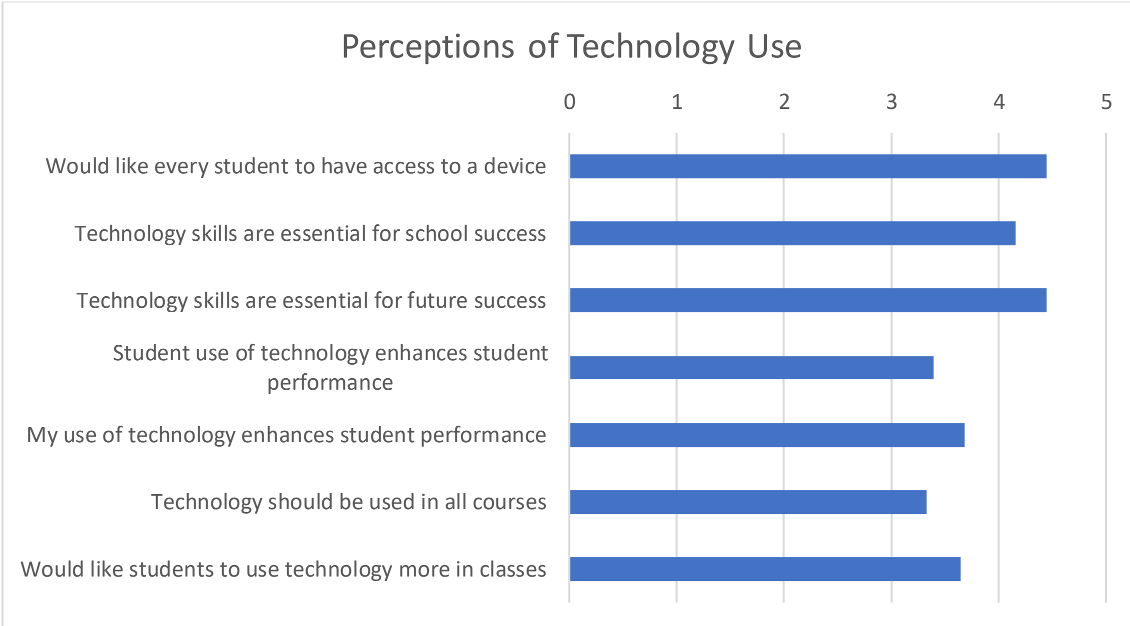

Figure B3: Teacher perceptions of technology use in the classroom. Scale used: agreement (1= Strongly disagree; 5=Strongly agree)

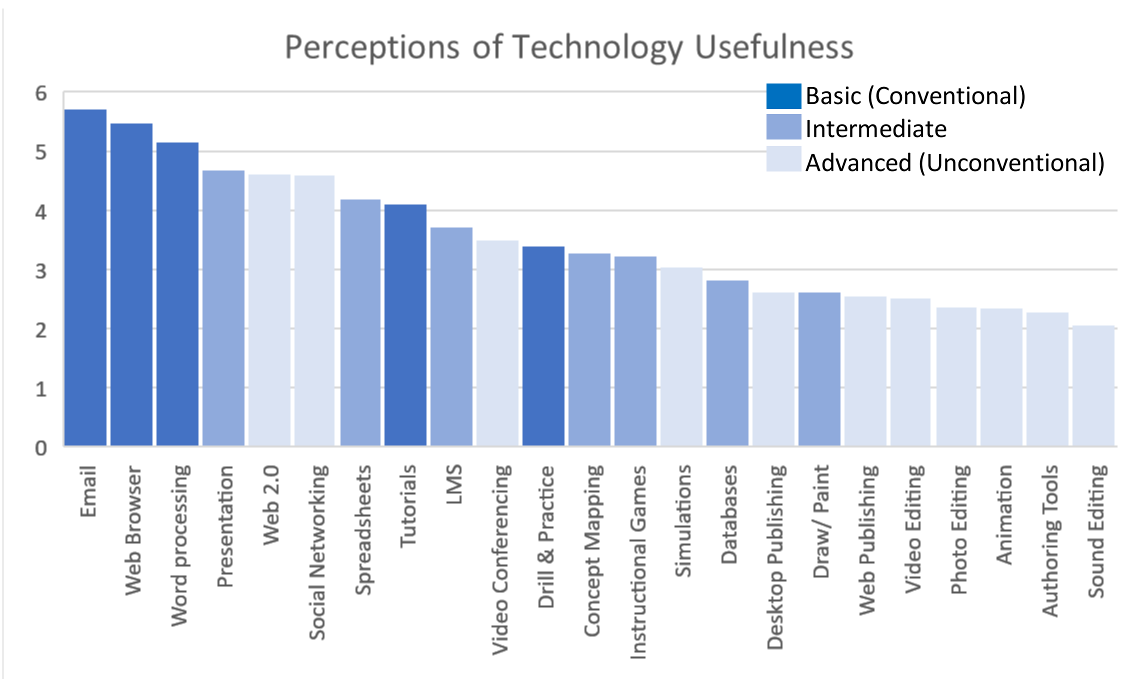

Figure B4: Perceptions of technology integration over various teaching activities. Colors on the graph represent different levels of technology use from conventional to unconventional. Scale used: Frequency (1= Not at all; 6= Multiple times per day).